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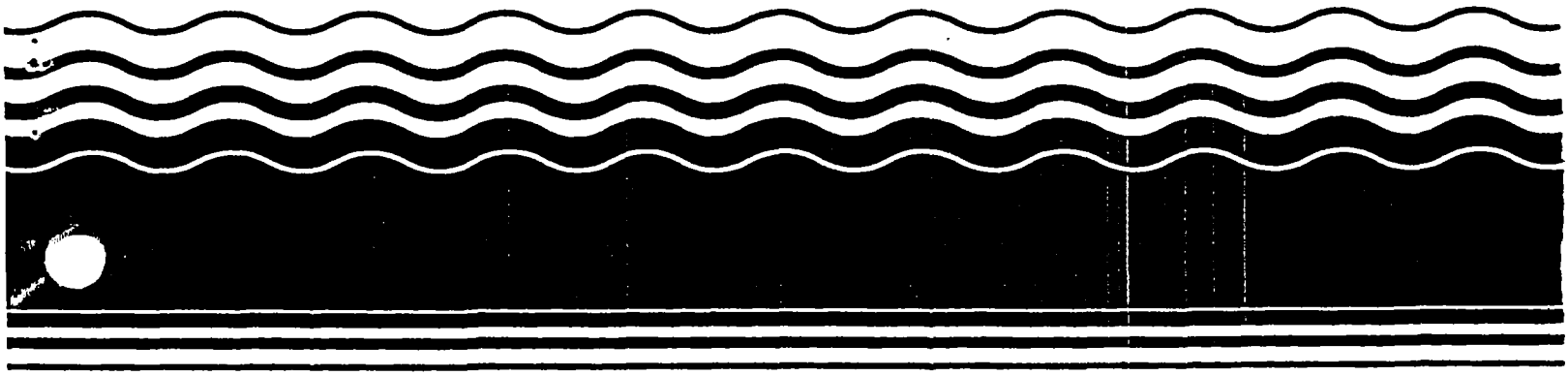
EPA Superfund Record of Decision:

United Heckathorn Site, Richmond, CA, 10/26/1994



RECORD OF DECISION

United Heckathorn Superfund Site
Richmond, California

EPA ID# CAD981436363

PART I - DECLARATION

Statement of Basis and Purpose

This Record of Decision ("ROD") presents the selected remedial action for the United Heckathorn Superfund Site ("the Site") in Richmond, California. This document was developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980, ("CERCLA"), as amended by the Superfund Amendments and Reauthorization Act of 1986 ("SARA"), 42 U.S.C. §§9601 et seq., and, to the extent practicable, in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300, and the laws of the State of California. This decision is based on the Administrative Record for the Site. The administrative record index identifies the documents upon which the selection of the remedial action is based.

Assessment of the Site

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Remedy

The United Heckathorn Superfund Site in Richmond, California, was used to formulate pesticides from approximately 1947 to 1966. Soils at the Site and sediments in Richmond Harbor were contaminated with various chlorinated pesticides, primarily DDT, as a result of these pesticide formulation activities. At the time of Site listing in 1990, a visible deposit of pesticide residue containing up to 100% DDT was present on the Lauritzen Channel embankment. Several response actions have already been taken to cleanup the most contaminated upland areas of the Site, including the embankment. Under EPA Removal Order 90-22, a group of Potentially Responsible Parties (PRPs) excavated the embankment deposit and transported it offsite to a permitted disposal facility. During subsequent actions through 1993 pursuant to the removal order, all known additional upland soil deposits containing high levels of pesticides were removed, as were piles of contaminated soils generated in earlier actions.

The final remedy addresses remaining hazardous substances, primarily in the marine environment. The major components of the selected remedy include:

- Dredging of all soft bay mud from the Lauritzen Channel and Parr Canal, with offsite disposal of dredged material.
- Placement of clean material after dredging.
- Construction of a cap around the former Heckathorn facility to prevent erosion.
- A deed restriction limiting use of the property at the former Heckathorn facility location to

non-residential uses.
- Marine monitoring to verify the effectiveness of the remedy.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate ("ARARs") to the remedial action, and is cost effective. The selected remedy uses engineering controls and institutional controls to address remaining hazardous substances at the Site. Concentrated wastes at the upland portion of the Site were addressed by previous removal actions.

Because this remedy will result in hazardous substances remaining onsite, a review will be conducted within five years after the commencement of remedial action, and every five years thereafter, to ensure that the remedy continues to provide adequate protection of human health and the environment.

John Wise

Felicia Marcus for
Regional Administrator

10.26.94

Date

PART II - DECISION SUMMARY

United Heckathorn Superfund Site
Richmond, California

1. Site Name, Location, and Description.

The United Heckathorn Site is located in Richmond Harbor, on the east side of San Francisco Bay (Figures 1 and 2) in Contra Costa County, California. The location of the former United Heckathorn facility (Figure 3) is currently being used as a marine shipping terminal operated by the Levin Richmond Terminal Corporation (LRTC). The area of contamination at the Site includes the northern five acres of the terminal and marine sediments in harbor channels including the Lauritzen, which is immediately adjacent to the location of the former Heckathorn facility, the Santa Fe, the Parr Canal, and the Inner Harbor Channel.

The upland area of the Site is currently fenced and occupied. Current and expected future zoning of the upland area of the Site permits only industrial use. Land use restrictions selected as part of the Site remedy will also permit only nonresidential, industrial or commercial uses in the future.

2. Site History and Enforcement Activities.

The upland area of the Site is currently owned by Levin Enterprises, Inc. The Site was used from approximately 1947 to 1966 by several operators, including the R.J. Prentiss Company, Heckathorn and Company, United Heckathorn, United Chemetrics, and Chemwest Incorporated (hereafter collectively referred to as "United Heckathorn") to formulate and package pesticides. No chemicals were manufactured onsite.

Documents from the 1950s and 1960s indicate that approximately 95% of Heckathorn's operations entailed processing the pesticide, DDT. The processing activities included mixing, blending, grinding, and packaging. Various solvents, including xylenes, were used to dissolve DDT and other pesticides into liquid formulations. Powder formulations were also prepared.

United Heckathorn employees apparently routinely washed out equipment containing pesticide residues. The wash water was permitted to either run through drains that discharged to the Lauritzen Channel, or to seep into the ground adjacent to the Site (Levine-Fricke, 1990). Later, settling tanks were used to recover pesticide residues from wash water; however, overflow and leakage from these tanks also occurred. In addition, accidental spills, leaks, and releases also occurred during the processing of liquid and dry pesticide formulations, which were conducted both inside and outside the United Heckathorn buildings.

In 1960, the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) inspected the facility and cited United Heckathorn for the release of DDT-laden wastewater into the Lauritzen Channel. In 1965, California Department of Fish and Game staff identified a discharge of wastewater overflow into the Lauritzen Channel and leakage from the pesticide settling tanks.

Pesticide processing activities at the Site ended in approximately 1966. Between 1966 and 1970, the United Heckathorn facility buildings were demolished and cleared from the Site. In the 1970s, the Site was apparently used primarily for bulk material storage. In 1981, the Levin Metals Corporation purchased the property from the Parr-Richmond Terminal Company and has been

operating the Site since that time as a bulk shipping facility.

In 1980, the United Heckathorn Site was inspected and sampled by CDHS as part of the Abandoned Sites Project. Chlorinated pesticides and metals were detected in soil samples, and the area was designated a state Superfund Site in March 1982. EPA listed the United Heckathorn Site on the CERCLA National Priorities List (NPL) in March 1990, and took over as lead agency in August 1990.

Interim response actions were conducted from 1982 to 1993 in the upland and embankment areas of the United Heckathorn Site. As early as 1982, contaminated soil, asphalt, and concrete from the United Heckathorn Site were excavated by the current landowner and moved to a nearby lot adjacent to the Parr Canal. These materials were subsequently transported to several hazardous waste disposal facilities. In 1983, soils containing high levels of pesticides were removed by the current landowner during routine maintenance and extension of onsite railroad lines. A 6-in. to 8-in. layer of gravel was placed over the surface of the Site, including a 6-in. layer of ballast rock over the Lauritzen Channel embankment and selected areas of high DDT concentrations. In 1986, during excavation for the construction of a train scale, high levels of pesticides were detected and approximately 60 cubic yards (yd^3) of soil were removed by the current landowner.

In November 1990, pursuant to EPA Removal Order 90-22, approximately 1500 yd^3 of soil and visible pesticide residue containing up to 100% DDT were excavated by several PRPs (Levin, Montrose, Parr, Shell, and Stauffer) from the Lauritzen Channel embankment. This excavation was taken back to the foundation of the former Heckathorn building 1, where a pesticide deposit approximately 3 ft thick was revealed beneath the foundation. Samples of this deposit contained approximately 30% DDT. An additional 1800 yd^3 of pesticide residue and contaminated soil were excavated by the same PRPs from this area in April 1991. The excavated material and stockpiles that had been placed onsite in the 1980s were hauled offsite by truck to permitted hazardous waste disposal facilities. A final soil removal action was completed in May 1993 by the same PRPs as well as Prentiss and Sherwin Williams. Assuming that the embankment deposit contained 30% DDT, over 99% of the mass of pesticides has been removed from the upland portion of the Site since 1990.

Marine sediment has not been the subject of prior removal actions or otherwise been remediated. However, as shown on Figure 3, the southeastern area of the Lauritzen Channel was last dredged for berth maintenance in 1985.

3. Highlights of Community Participation.

Six fact sheets have been released describing activities at the Site. In July, 1994 EPA released a proposed plan and the Administrative Record for the Site. Site documents were made available at the agency Superfund Records Center and at the Richmond Public Library, and a public notice was published allowing 30 days for public comment on the Proposed Plan. A public meeting was held on August 2, 1994 to describe the proposed remedy and receive comments. The public comment period was then extended an additional 30 days at the request of PRPs. Three persons made comments at the public meeting, and six written comments on the proposed plan were received during the comment period. Responses to all significant comments received during this period are contained in the attached "Analysis of Public Comments." The decision for this Site is based upon the Administrative Record.

4. Scope and Role of Remedial Actions.

The remedial actions selected in this Record of Decision are expected to be the final response actions performed at the Site. As described in the Site history above, significant interim response measures were performed at the Site in the past. These removal actions addressed the principal threats at the upland portion of the Site.

The selected remedy addresses the contaminants remaining in sediments at the Site, as well as the low levels of contaminants remaining in soils at the Site.

5. Site Characteristics.

The nature and extent of contamination at the United Heckathorn Site has been delineated by the combination of state-ordered Site investigations which occurred prior to NPL listing, and EPA's subsequent Remedial Investigation (Battelle, 1994). As discussed above, large deposits of extremely high levels of pesticides remained in upland soils after United Heckathorn ceased operations in 1966. These have been the subject of extensive excavation and removal actions over the past three years.

A soils database representing current Site conditions was compiled in EPA's Human Health Risk Assessment (ICF Technology, 1994) from the previous Site studies and removal action reports. A conservative estimate of the remaining mean Site soil concentrations of the primary Contaminants of Concern (COCs), DDT (total) and dieldrin, are 64 and 5.7 milligrams per kilogram (mg/kg), respectively. These estimates are conservative because the soils database includes the large number of additional samples which were taken to delineate the hot-spot areas for the removal actions. The actual mean Site concentrations are likely to be lower.

DDT at levels exceeding 1 mg/kg in upland soils extends over the upland portion of the Site as shown in Figure 4. The total mass of these upland soils is approximately 95,000 tons (Levine-Fricke, 1993). Confirmation sampling performed during the excavations of the most contaminated soil areas indicated that the concentrations drop to nondetectable levels in the younger bay mud immediately below the upland soils, demonstrating that the homogeneous silty-clay bay mud underlying the Site is an effective barrier to downward migration of Site chemicals.

Due to the Site's proximity to San Francisco Bay, the shallow groundwater at the Site is naturally saline and is not a source of drinking water under state or federal law.

In 1992, EPA performed a screening assessment of offsite soils (ICF Technology, 1994) in order to determine whether the historic operations of United Heckathorn could have released pesticides into the air in sufficient quantities to cause current levels of concern in nearby off-site residential soils. Sampling locations were chosen along Cutting Boulevard and immediately north of Highway 580, because the meteorological analysis for EPA's 1988 air monitoring program indicated that the strongest prevailing winds at the Site blow due north. The sampling program was therefore deliberately biased to target the area which would have had the highest levels of pesticides, had Heckathorn caused contamination. All off-site soil sampling results were well within acceptable levels for protection of human health.

The results of the RI of marine sediment, however, indicate that the occurrence of pesticides at the Site, particularly the Contaminants of Concern, DDT and dieldrin, is more widespread and at concentrations orders of magnitude higher relative to San Francisco Bay background levels than other detected contaminants. The areal and vertical distribution of marine contamination is summarized below.

Vertical core segments and channel edge grab samples were analyzed for chlorinated pesticides to delineate the areal and vertical extent of marine contamination. Results indicated that significant pesticide contamination was limited to the soft geologically recent "younger bay mud"; samples from the hard underlying "older bay mud" generally contained only traces of pesticides. Figure 5 presents the average total DDT concentration in the younger bay mud in the inner Richmond Harbor. It is significant to note that the concentration contours on this figure must be presented on a log scale in order to depict the gradient of six orders of magnitude between the Lauritzen Channel and Point Potrero. The maximum and median total DDT and maximum dieldrin concentrations throughout the study area are also shown.

Pesticide concentrations were highest in the Lauritzen Channel, and decreased with increasing distance from the former United Heckathorn Site, clearly indicating that Heckathorn was the source of contamination. The highest total DDT concentration of 633,000 micrograms per kilogram (μg/kg) dry wt was measured in a sample from 1 ft to 3 ft below the mudline in the center of the channel. Pesticide concentrations of greater than 100,000 μg/kg were detected in sediment from the northern and western portions of the channel. The median total DDT concentration was approximately 47,000 μg/kg at the head of the Lauritzen Channel, which has not been dredged in a number of years. The median concentration of total DDT decreased to about 14,000 μg/kg in the western, undredged portion of the channel, and to 1500 μg/kg in the dredged portion of the channel near the Levin terminal. Dieldrin concentrations were lower (maximum concentration of 16,000 μg/kg), but exhibited the same spatial trend in relative concentration.

Total DDT concentrations in sediment decreased by at least two orders of magnitude from the Lauritzen Channel to the Santa Fe Channel. The median concentration of total DDT in the younger bay mud was 110 μg/kg in the upper Santa Fe Channel and 210 μg/kg in the federally maintained portion of the channel. DDT and dieldrin concentrations were higher in the federally maintained portion of the Santa Fe Channel, which includes the area downstream of the Lauritzen Channel. Total DDT and dieldrin concentrations decreased by another order of magnitude from the Santa Fe Channel to the Inner Harbor Channel. The median total DDT concentration was 60 μg/kg in the upper Inner Harbor Channel, and 10 μg/kg in the lower Inner Harbor Channel. The maximum total DDT concentration near Point Potrero was 19 μg/kg, which is approximately equal to the median DDT concentration for the periphery of San Francisco Bay, excluding the Lauritzen Channel (Long et al., 1988).

Pesticide concentrations in Parr Canal sediment were lower than those measured in the Lauritzen Channel but greater than those measured in Santa Fe or Inner Harbor Channels. The maximum and median total DDT concentrations measured in Parr Canal sediment were 4080 μg/kg and 840 μg/kg, respectively. The maximum dieldrin concentration was 170 μg/kg. The Parr Canal is significantly narrower than it was in the 1940's, due to filling which (based on aerial photographs) occurred sometime between 1958 and 1968. Some of the material used to fill the canal may have been dredged from the harbor, possibly explaining the elevated levels of pesticides in Parr Canal sediments.

Grab samples collected from channel edges throughout the study area showed the same spatial trend in pesticide concentrations as the core samples. The total DDT concentrations in channel edge samples were consistent with the median concentration measured in core samples from that area.

Contaminant concentrations in the younger bay mud were generally not well stratified. In the shallow portions of the Lauritzen Channel, contaminant concentrations increased, and then decreased with increasing depth. The most highly contaminated sediment was generally found from 1 ft to 5 ft below the mudline. In the Santa Fe Channel, the most contaminated sediment was

found down-channel of the mouth of the Lauritzen Channel in the surface sediment, and just up-channel of the mouth in deeper sediment. Contaminant concentrations were generally higher in deeper sediment in the Inner Harbor Channel. Analysis of the volumes of contaminated sediments and the average concentrations in harbor channels indicates that 98% of the mass of DDT in harbor sediments is confined to the Lauritzen Channel.

Selected core samples collected during the marine RI were analyzed for polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), metals, and butyltins. In general, sediment from the upper Lauritzen Channel and Parr Canal had higher concentrations of PAHs, PCBs, and metals than sediment from the Santa Fe and Inner Harbor Channels. This is probably because the larger channels have been routinely dredged for navigation, whereas the northern Lauritzen and Parr have not. Only the pesticides, DDT and dieldrin, are consistently found in sediments and biota at levels orders of magnitude higher than the regional background levels.

6. Applicable or Relevant and Appropriate Requirements (ARARs)

Federal and state environmental laws which have been determined to be ARARs for the remedy are summarized below. Chemical-specific ARARs are discussed first, followed by other requirements.

Surface Waters: ARARs for surface water include EPA's ambient water quality criteria for DDT and dieldrin. These are the primary basis for the Site remediation goals.

EPA Ambient Water Quality Criteria. Section 304 of the Clean Water Act required EPA to publish criteria for water quality that accurately reflect the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare, including effects on plankton, fish, shellfish, wildlife, and plant life, which may be expected from the presence of pollutants in any body of water, based on the substances' whole-water concentration. The ambient water quality criteria for DDT and dieldrin were published in October 1980. The human health values have been updated since the original criteria publications in 1980 to reflect revised carcinogenic potency values from EPA's Integrated Risk Information System (IRIS) database (see Final Rule, 40 CFR Part 131, 57 FR 60848, December 22, 1992).

The derivation of EPA's ambient water quality criteria is discussed at length in the ecological assessment (EPA, 1994). Criteria for the protection of saltwater aquatic life are, for most pollutants, based upon toxic effects data for water-column organisms. However, for DDT and its metabolites, which bioaccumulate to high levels and may cause toxicity to organisms at higher trophic levels, it was determined that more restrictive criteria were necessary to protect fish-eating birds. The chronic marine aquatic life criterion is 1 ng/L (10^{-9} g/l, EPA 1980, EPA 440/5-80-038]). The water quality criterion for the protection of human health from the consumption from the bioaccumulation of DDT in fish is 0.59 ng/l, based on achieving a 1 X 10^{-6} lifetime excess cancer risk level.

The chronic marine aquatic life criterion for dieldrin of 1.9 ng/l is also residue-based, and was set at the level which would result in the achievement of the Food and Drug Administration's (FDA) action level in fish oil after bioaccumulation (EPA 1980, EPA 440/5-80-019]). This criterion is protective of sensitive aquatic organisms. The water quality criterion for the protection of human health from the consumption from the bioaccumulation of dieldrin in fish is 0.14 ng/l, based on achieving a 1 X 10^{-8} lifetime excess cancer risk level. The EPA aquatic life and human health water quality criteria for DDT and dieldrin are listed in Table 1.

TABLE 1. EPA Ambient Water Quality Criteria

Chemicals	Saltwater Aquatic Life (ng/L) 24-hour average	Human Health (ng/L)
DDT[a]	1.0	0.59
Dieldrin	1.9	0.14
(a) The sum of the 4,4'- and 2,4'- isomers of DDT, DDD (TDE), and DDE.		

Section 121(d)(2)(A)(ii) of CERCLA requires that remedial actions meet federal Water Quality Criteria established under Section 304 or 303 of the Clean Water Act where such WQC are determined by EPA to be relevant and appropriate to remedial actions at the Site. See 42 U.S.C. § 9621(d)(2)(A)(ii) and 40 C.F.R. § 300.430(e)(2)(i)(G). In evaluating whether specific WQC are relevant and appropriate to remedial actions at Superfund Site, CERCLA requires EPA to consider four criteria: 1. the uses of the receiving water body; 2) the media affected; 3) the purposes of the criteria and 4) current information. See 42 U.S.C. § 9621(d)(B)(i). See also U.S. EPA, CERCLA Compliance with Other Laws Manual - CERCLA Compliance with the CWA and SDWA (OSWER Pub. 9234.2-06/FS, Feb. 1990).

EPA guidance concerning determinations that WQC are relevant and appropriate to remedial action at a Superfund Site provides that:

> A water quality criteria component for aquatic life may be relevant and appropriate when there are environmental factors that are being considered at a Site, such as protection of aquatic organisms. With respect to the use of water quality criteria for the protection of human health, levels are provided for exposure both from drinking the water and from consuming aquatic organisms (primarily fish) and from fish consumption alone. Whether a water quality criterion is appropriate depends on the likely routes of exposure.

U.S. EPA, CERCLA Compliance With Other Laws Manual: Interim Final at 1-15 (EPA 540-G-89-006, Aug. 1989).

Both the marine chronic and human health WQC for DDT and dieldrin are relevant and appropriate to remedial actions at this Site since both aquatic and wildlife and humans may be exposed to these contaminants either directly or through consumption of contaminated organisms. As discussed in the Ecological Risk Assessment, aquatic organisms are present in all channels at the Site, which are a part of San Francisco Bay. Fish eating-birds feed in all channels in the harbor. In fact, the particular bird upon which the marine chronic water quality criterion for DDT was based is the California brown pelican, an endangered species, which has been observed feeding in the most contaminated channels at the Site. As discussed in the Human Health Risk Assessment, fishermen catch and consume fish from the Inner Richmond Harbor channels. In 1986, the State of California Department of Health Services ordered the posting of the Lauritzen Channel to warn fishermen of the fish and shellfish contamination. On April 7, 1994, the Cal-EPA Department of Toxic Substances Control issued an advisory against consuming any resident bottom fish, such as white croaker, from anywhere in the Inner Richmond Harbor.

The beneficial uses designated by the State of California for central San Francisco Bay waters, which are discussed below, include fishing, wildlife habitat, preservation of rare and endangered species, fish migration, fish spawning, shellfish harvesting, and estuarine habitat.

EPA's Ambient Water Quality Criteria were specifically developed to protect beneficial uses such as these.

Porter-Cologne Water Quality Act, San Francisco Bay Regional Basin Plan, and Fish and Game Code. The release of hazardous substances to surface waters is controlled under the Porter-Cologne Water Quality Control Act and implementing regulations, and the state Fish and Game Code §5650.

Beneficial uses of surface waters were designated in the Water Quality Control Plan for the San Francisco Basin (the Basin Plan) adopted by the Regional Water Quality Control Board (SFBRWQCB, 1986). The Basin Plan designates the following beneficial uses of Central San Francisco Bay, which includes the waters at the Site:

Industrial Service Supply
Industrial Process Supply
Navigation
Water Contact Recreation
Non-contact Water Recreation
Commercial and Sport Fishing
Wildlife Habitat
Preservation of Rare and Endangered Species
Fish Migration
Fish Spawning
Shellfish Harvesting
Estuarine Habitat

The Basin Plan also contains the following narrative objective:

"All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce detrimental responses in aquatic organisms. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species and/or significant alterations in population or community ecology or receiving water biota. Other relevant biological measures will be considered by the Regional Board in evaluating compliance with this objective. Additionally, effects on human health due to bioconcentration will be considered."

Resolution 68-16: Statement of Policy with Respect to Maintaining High Quality of Waters in California. The State Water Resources Control Board adopted Resolution 68-16 on October 28, 1968. The Basin Plan, discussed above, states: "Whenever the existing quality of water is better than the quality of water established herein as objectives, such existing water quality shall be maintained unless otherwise provided by State Water Resources Control Boars Resolution 68-16." The SFBRWQCB has identified Resolution 68-16 as a potential ARAR for the United Heckathorn Site. While EPA does not agree that Resolution 68-16 is an ARAR, EPA and the State agree that achieving the water quality criteria identified above would meet the requirements of 68-16 regardless of whether or not it is an ARAR.

Soils and Sediments

No chemical-specific ARARs were identified as remedial goals for soils or sediments at the Site. Based on the results of the ecological assessment, mean sediment levels were calculated to prevent violations of the ARARs for surface waters, and to meet the National Academy of Sciences

(NAS) action level for DDT in fish to ensure protection of fish-eating birds, including endangered species (see discussion below).

California Code of Regulations, Title 22. The state of California has developed chemical-specific regulatory criteria for the identification of hazardous and extremely hazardous wastes, based on Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC) values (California Code of Regulations, Title 22, Sections 66699 and 66723). Any waste containing a substance at a concentration equal to or exceeding a listed TTLC is classified as a hazardous waste by the California Department of Toxic Substances Control (DTSC). Extremely hazardous wastes are also classified by DTSC using TTLCs. STLCs are related to the Waste Extraction Test (WET), also described in Title 22. Any waste which produces an extract in the WET test the concentration of which exceeds an STLC, is classified as a hazardous waste by DTSC. The TTLCs and STLCs for the major COCs at the Site, DDT and dieldrin, are listed in Table 2.

TABLE 2. State of California Hazardous Waste Limits

Chemicals	TTLC (mg/kg wet wt)	STLC (mg/kg wet wt)
DDT, DDD, DDE	1.0	0.1
Dieldrin	8.0	0.8

All materials known to contain concentrations of substances exceeding the limits which classify extremely hazardous wastes have been removed from the Site. Based on the results of previous investigations and the marine RI, approximately 95,000 tons of soils in the upland area of the Site and approximately 65,000 yd^3 of sediments in the Lauritzen Channel and Parr Canal exceed the California TTLC for DDT. No sediments outside these channels exceed the levels listed in Table 2. Although the TTLCs and STLCs do not represent cleanup levels, soils and sediments with chemical concentrations higher than the TTLCs or STLCs would be classified as hazardous under California law if they were dredged or excavated at the Site.

EPA has developed chemical-specific criteria for the identification of hazardous waste under the Resource Conservation and Recovery Act (RCRA). For the COCs at this Site, the criteria are not concentration-based, but are instead based on the source of the constituents (40 CFR 261.33). Product spills, for example, are RCRA-regulated, but generally releases of chemicals contained in process waste streams are not (40 CFR 261.33(d)(comment)). Based on a review of historical documents, the presence of COCs in marine sediments and remaining soils appears to be due to releases contained in waste streams from United Heckathorn's processes. Therefore, EPA has determined that the contaminated soils and marine sediments are not hazardous wastes regulated under RCRA.

Groundwater. There are no chemical-specific ARARs for the concentration of COCs in Site groundwater. Previous investigations found that salinity levels exceed federal (40 CFR 144.3) and state (SWRCB Resolution No. 88-63) limits for underground sources of drinking water. Consequently, the shallow groundwater at the Site is not considered a potential source of drinking water as defined under state and federal law.

The water quality criteria for surface waters discussed above do not apply to groundwater, although they might provide a basis for developing remediation goals in groundwater if there was a

complete pathway by which contaminants in groundwater caused violations of the criteria in surface water. However, as discussed in the previous chapter, an analysis of groundwater transport to the bay was made in 1986 as part of the initial state-ordered Site investigation. Although extremely high levels of pesticides were present in soils at that time, there were only sporadic detections of low levels of pesticides in groundwater samples, and modeling indicated that this potential pathway would not cause violations of state surface water quality objectives. Based on this analysis, groundwater monitoring was not required in subsequent state-ordered Site investigations. Subsequently, all highly contaminated soils containing approximately 99% of the mass of pesticides were removed from Site soils, further reducing any potential threat.

Air. There are no chemical-specific ARARs, such as National Ambient Air Quality Standards (NAAQS) or National Emission Standards for Hazardous Air Pollutants (NESHAPS), for the concentrations of Site COCs in the air. Air monitoring was performed at the Site prior to the removal of extremely high levels of exposed pesticides from Site soils. Even under those conditions, the concentrations in onsite and offsite air were well below levels of concern.

Fish and Shellfish. There are no chemical-specific ARARs for the concentration of COCs in fish and shellfish. The NAS saltwater action levels are TBCs, which provide an additional level of protection to fish-eating birds beyond the level that is the basis of the surface water ARARs for aquatic life. The FDA action levels for the marketability of fish and shellfish are also TBCs for protecting human health, but they are much less stringent than the levels that would be achieved by meeting the surface water ARARs discussed above.

The NAS and National Academy of Engineering published recommendations in 1972 for pollutant residues in compoSites of 25 or more whole fish of any species within the same size range as those consumed by any bird or mammal in the marine environment (EPA-R3-73-033, March 1973). The document cites studies demonstrating DDE induced shell thinning in mallards, American kestrels, Japanese quail and ring doves, and an inverse relationship between shell thickness and concentrations of DDE in eggs of wild populations of herring gulls, double-crested cormorants, great blue herons, white pelicans, brown pelicans, and peregrine falcons. The document concludes that a wet weight tissue range of 0.1 mg/kg to 0.5 mg/kg (100 μg/kg to 500 μg/kg) is "evidently higher than one which would permit successful reproduction of several fish-eating and raptorial birds." The criterion for DDT is 50 μg/kg, which is one-third the level which was the basis for the EPA water quality criteria discussed above.

Since the US Fish and Wildlife Service raised concerns that the EPA criteria for DDT might not be stringent enough for the protection of fish-eating birds, and an endangered species (the brown pelican) has been observed feeding at the Site, the NAS action level was retained as a TBC to help determine the protectiveness of remediation (see 55 FR 8745).

Other Requirements

Endangered Species Act. The Endangered Species Act of 1973, 16 USC §1531 et seq., requires the conservation of species of fish, wildlife and plants that are threatened with extinction. Compliance with the act at Superfund Sites requires the identification of any threatened or endangered species or of its critical habitat that would be affected by a proposed remedial action.

The U.S. Fish and Wildlife Service (FWS), which is the federal trustee for the protection of migratory birds, provided a list of endangered species that are known to nest in central or northern San Francisco Bay, or are likely to feed regularly in the immediate vicinity of Richmond Harbor (Table 3). Among these, the California brown pelican has been observed by EPA personnel feeding in all channels in Richmond Harbor, including the most contaminated waterways.

The FWS raised the concern that the tissue residue basis (0.15 mg/kg DDT in prey) of the surface water ARARs resulted in reproductive levels in pelicans that were still 10% to 30% below the levels needed to maintain a stable population, described in the 1976 study used to set the criteria. It should be emphasized, however, that the reproductive effects occurred when contamination was widespread in the birds' range, and that the contamination in Richmond Harbor is restricted to a small area. Nevertheless, the selected remedy is expected to also achieve the NAS saltwater action level for DDT in fish (0.05 mg/kg), which was identified as a TBC for determining the protectiveness of remediation.

TABLE 3. Endangered Species

Common Name	Nests In SF or San Pablo Bays	Feeds In/Around Richmond Harbor	Prey
Brown Pelican		Y	Fish[a]
Bald Eagle			Omni.[b]
Peregrine Falcon	Y	Y	Bird[c]
Clapper Rail	Y		Invert.[d]
Least Tern	Y	Y	Fish

(a) Fish: consumes primarily fish.
(b) Bird: consumes primarily birds.
(c) Omni.: diet usually omnivorous/scavenger.
(d) Invert.: consumes primarily small- to medium-sized invertebrates.

California Endangered Species Act. The goal of the California Endangered Species Act (California Fish and Game Code §2050) is to conserve, protect, restore and enhance any endangered or threatened species and its habitat. Among the birds likely to nest or feed in the area, most of those that are listed as endangered or threatened by the state are also listed federally. The one exception is the California black rail, a state threatened species.

CDFG submitted the names of two potentially-affected plant species, both of which are listed as rare and have distributions in the north Bay and delta. They are Mason's lilaeopsis, a minute, turf-forming perennial plant in the carrot family, and soft bird's-beak, a sparingly-branched, semi-parasitic herbaceous annual plant in the figwort family. The known distribution of Mason's lilaeopsis, which is found on saturated clay soils regularly inundated by waves and tidal action, appears to be limited to the bay delta. Soft bird's-beak occurs in the coastal salt marshes and brackish marshes of northern San Francisco and Suisun Bays.

The surface water ARARs discussed previously are five orders of magnitude more stringent than the levels necessary to protect aquatic plants. None of the potential remedies would involve destruction of rare plants or their habitat.

Coastal Zone Management Act (CZMA). Section 307(c)(1) of the CZMA requires that federal agencies conducting or supporting activities directly affecting the coastal zone conduct or support those activities in a manner that is consistent with approved state coastal zone management programs. All remedial alternatives analyzed would affect the coastal zone. Under CERCLA Section 121(e), 42 U.S.C. § 9621(e), onsite activities are not subject to administrative review or permitting

processes, but they must be consistent with the substantive requirements of the coastal zone management plan. The approved coastal zone management program for San Francisco Bay includes the McAteer-Petris Act and the San Francisco Bay Plan, and is administered by Bay Conservation and Development Commission (BCDC).

The McAteer-Petris Act and the Bay Plan were developed primarily to halt uncontrolled development and filling of the bay. Their broad goals include reducing bay fill and disposal of dredged materials in the bay, and maintaining water quality and the ecological integrity of the bay. Generally, filling of the bay is allowable only when public benefits exceed public detriment from the loss of water areas, the filling is for a water-oriented use, and there is no alternative upland location available.

Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act, 42 U.S.C § 1344, regulates dredging and filling in waters of the United States. Several of the remedial alternatives analyzed include dredging contaminated sediments. Some of the potential disposal options include filling in waters of the United States. The United States Army Corps of Engineers (USACE) usually issues permits to conduct the above activities; however, since the actions analyzed would all occur onsite, permits would not be required pursuant to Section 121(e) of CERCLA, although the substantive requirements of the laws would still have to be met.

The determination of the acceptability of fill in waters of the United States is made under the Clean Water Act Section 404(b)(1) guidelines, which were promulgated in 40 CFR Part 230. The discharge of dredged or fill material is prohibited if there is a practicable alternative to the proposed discharge that would have less impact on the ecosystem, so long as the alternative does not have other significant adverse environmental consequences.

California Hazardous Waste Control Law. California's hazardous waste facility closure requirements, 22 California Code of Regulations, Chapters 14 and 15, "Closure and Post Closure," are not ARARs with respect to the upland portions of the United Heckathorn Site because it is neither a hazardous waste facility nor a landfill. Some of the remedial alternatives analyzed would involve the consolidation and onsite containment of contaminated sediment. In the analysis of alternatives, operational requirements found in Title 22 of the California Code of Regulations are discussed, including limited long-term management, Site and cover maintenance, and institutional controls, including land use restrictions.

7. Summary of Site Risks and Remediation Levels.

Risk assessments were conducted by EPA to evaluate the threat to human health and the environment posed by contamination from the United Heckathorn Site. Results of these assessments and the final remediation levels established to address Site risks are summarized below.

Human Health Risk Assessment. The Baseline Human Health Risk Assessment for the Site was performed by ICF Technology Inc. for EPA (ICF Technology, 1994). The results indicate that among the various potential exposure pathways for Site contaminants, only the consumption of fish poses risks that are above EPA's acceptable risk range.

COCs at the Site were selected for evaluation in the risk assessment using the Site soil and sediment data collected by HLA (1986), Levine-Fricke (1990, 1991, 1993), and Weston (1993). The COCs selected for onsite soils were DDT (and metabolites), dieldrin, aldrin, endrin, and lead. Of

these, DDT and dieldrin are the most prevalent contaminants and are the primary contributors to risk. COCs selected for sediments were DDT and dieldrin.

Six exposure pathways were identified as potential concerns at the Site, as follows:

- ingestion and dermal adsorption of chemicals in onsite surface soils by workers at the Site;
- inhalation of fugitive dust from surface soils by onsite workers;
- ingestion and dermal adsorption of chemicals in onsite surface and subsurface soils by temporary construction workers at the Site;
- inhalation of fugitive dust from soils by temporary construction workers at the Site;
- incidental ingestion and dermal adsorption of chemicals in offsite soils by nearby residents, and;
- ingestion of contaminants in fish and shellfish from the Lauritzen, Santa Fe, and Inner Richmond Harbor Channels by fishermen and their families.

The onsite exposure pathways assume that the Site will continue to be used for commercial or industrial uses in the future. This is in accordance with the Bay Conservation and Development Commission's (BCDC) San Francisco Bay Plan which designates the area for port priority or water-related industry use, and the City of Richmond's M-3 (heavy industry) zoning of the Site and surrounding properties.

The six potential exposure pathways were evaluated according to EPA guidance, which uses conservative estimates of chemical toxicity and exposure, and cumulative risk from the addition of pathways. Chemical concentrations used in the risk assessment included both average and either Reasonable Maximum Estimates (RME) of Site concentrations or maximum measured values. EPA baseline human health risk assessments intentionally present conservative (i.e. health-protective) estimates of Site risks. Actual risks are likely to be lower and may in fact be zero.

The assessments for onsite worker exposure and offsite residential exposure are more conservative than usual because the soils databases in both cases were influenced toward higher values. The onsite soils database was skewed by the high number of samples taken to delineate the hot-spot excavation areas. Offsite soil screening samples were intentionally taken only in the immediate downwind area, which would have had the highest concentration had contamination occurred.

The cumulative risks calculated for the onsite soil exposure scenarios indicate that the removal actions that have occurred to date have reduced upland Site concentrations of chlorinated pesticides to acceptable levels. The highest RME cancer risk calculated for the various onsite upland worker scenarios (ingestion, dermal adsorption and inhalation of fugitive dusts from surface soils by a permanent worker) is $1x10^{-4}$, and the maximum Hazard Index (HI) for noncarcinogenic effects is 1. More probable estimates for the same exposure scenario are $2x10^{-5}$ and <1. Risks for other onsite worker scenarios are lower. Since the onsite soils database is skewed to produce conservative results and EPA's acceptable risk range is 10^{-4} to 10^{-6}, onsite risks associated with chlorinated pesticides are acceptable.

Onsite risks for occupational exposure to lead were evaluated using EPA's 500 mg/kg to 1000 mg/kg acceptable range for residential exposure, and the state of California's draft procedure for the assessment of adult exposure to lead in soil. Mean onsite lead levels are below 500 mg/kg, and the RME lead concentration results in a 95th percentile adult blood lead level below the target concentration of 10 micrograms per deciliter (μg/dL) using the state's draft procedures. Therefore, onsite lead levels are acceptable.

Offsite residential risks for COCs in nearby soils were evaluated using the maximum values obtained in EPA's soil screening survey and conservative exposure assumptions, including childhood exposure. All results were well within the acceptable risk range for carcinogenic effects and below an HI of 1 for noncarcinogenic effects. (i.e., the maximum values measured were below a Hazard Index of 1 for noncarcinogenic effects, and below a lifetime excess cancer risk level of 10^{-4} for carcinogenic effects).

Risks to fishermen and their families who consume fish caught in the inner Richmond Harbor were evaluated using information from two sources: fish tissue data generated as part of EPA's ecological assessment of the Site, and community interviews with individuals who fish or are familiar with fishing practices in Richmond Harbor. The community interviews confirmed that fishing occurs regularly in Richmond Harbor, particularly at a Site in the Inner Harbor Channel near the Parr Canal that has unrestricted access. Although it could not be determined from the limited interviews performed whether fishing at subsistence rates occurs in the harbor, it is clear that the fishermen are from poor, minority communities, and that the fish are caught for consumption. Fishing in the Lauritzen Channel is restricted because it is surrounded by fenced industrial facilities, and fishing from boats is discouraged by warning signs in English, Spanish, Vietnamese and Laotian, posted under a 1986 order of the CDHS. Baseline risk assessments, however, assume that institutional controls, such as fences and posting, will be ineffective or not maintained. In fact, a person was photographed fishing from an industrial facility on the Lauritzen Channel during the EPA field sampling for the ecological assessment.

The results of the risk calculations indicate that the risks from long-term consumption of either whole fish or fillets of fish caught in the Lauritzen Channel are unacceptable. Using the exposure scenario which is the basis of EPA's water quality criteria for fish consumption, the lifetime excess cancer risk associated with Site COCs is above 10^{-3} for consumption of whole fish, and above 10^{-4} for fillets. In the Santa Fe and Richmond Inner Harbor Channels, lifetime excess cancer risks are within the acceptable range using the same exposure scenario. If consumption were to occur at subsistence rates, the associated risks would be approximately 10 fold higher. The proposed remedy is expected to achieve protective levels for contaminants of concern under either exposure scenario.

On April 7, 1994, the California Department of Toxic Substances Control issued an advisory against consuming any resident bottom fish, such as white croaker, from anywhere in the Inner Richmond Harbor. The State's advisory was based on levels of contaminants found in fish purchased from resident fishermen at the Parr Canal area. These fish were larger than those in EPA's studies and had slightly higher contaminant levels. The primary risk associated with the consumption of fish caught outside the Lauritzen Channel is due to contamination with polychlorinated biphenyls (PCBs), although the State would have issued the advisory based upon DDT and dieldrin contamination alone. The source of PCBs is unknown. PCBs are not related to the United Heckathorn Site, and may be present in fish throughout the bay. PCB levels in Richmond Harbor sediments are not elevated relative to typical levels in the bay.

Ecological Assessment. The Ecological Risk Assessment for the United Heckathorn Site was performed by EPA (EPA, 1994). The operations of United Heckathorn from 1947 to 1966 resulted in the release of DDT and other pesticides to and from the shoreline of the Lauritzen Channel and to San Francisco Bay. Today, in the waters of Richmond Harbor near the former plant, high levels of DDT and dieldrin remain in marine sediments. DDT and dieldrin bioaccumulate in marine organisms to the highest levels found in the state of California.

The goals of EPA's ecological assessment were to assess the threats posed to the environment by the contaminants released from United Heckathorn and to determine cleanup levels

protective of the beneficial uses of San Francisco Bay.

The waters of Richmond Harbor are part of San Francisco Bay, the West Coast's largest estuary. The estuary sustains a complex ecosystem containing thousands of species of fish, invertebrates, birds, mammals, insects, amphibians, plants and other life, as well as nearly half the waterfowl and shorebirds migrating along the Pacific flyway. Fish-eating birds, including cormorants, grebes, loons, kingfishers, and California brown pelicans (an endangered species) feed in the most contaminated channels at the Site.

The initial components of EPA's ecological assessment included a review of previous studies in the area. Highlights of this review included the findings that sediment concentrations of DDT are elevated to acutely toxic levels in the Lauritzen Channel and decline by over four orders of magnitude to near background levels in the vicinity of Point Potrero. DDT and dieldrin concentrations are extremely elevated in transplanted mussels and resident invertebrates in the Lauritzen Channel and decline by two orders of magnitude in the Inner Richmond Harbor Channel. Fish caught in the Lauritzen Channel in 1986 contained extremely high levels of DDT, which were comparable to the levels measured in 1960. Finally, a study of migratory waterfowl in San Francisco Bay found that only those which wintered in Richmond Harbor significantly accumulated metabolites of DDT. Although other chemicals are present in Richmond Harbor, they are not consistently found at levels notably above background or above levels that are likely to cause toxicity, in marked contrast to DDT and dieldrin, which are many orders of magnitude above background and were selected as the COCs for the study.

The next preliminary phase of the study was a review of the available standards, criteria, and scientific literature regarding ecological impacts of the COCs to determine as far as possible the contaminant levels in various media that could adversely impact sensitive organisms. This review indicated the ecological receptors likely to be the most sensitive and helped guide the selection of field and laboratory studies. EPA's ambient water quality criteria for DDT and dieldrin were identified as applicable to the Site. The marine chronic criteria for DDT (1 nanogram per liter, ng/L) is based upon preventing bioaccumulation in fish to levels harmful to sensitive marine birds.

The major phase of the study involved field and laboratory measurements of contaminant concentrations in various media and the performance of standard benthic tests for determining impacts from contaminated sediments. Most of the field samples were taken in October 1991. Additional fish and shellfish samples were taken in April 1992. The studies included bulk sediment toxicity testing, benthic community analyses, bioaccumulation testing, and chemical analyses in sediments, surface waters, and tissues of benthic organisms and fish and shellfish collected in trawls. An additional goal of these studies was the determination of the relationship between sediment contaminant concentrations and the concentrations in other media so that a sediment cleanup concentration could be determined which would result in the attainment of water quality criteria and protective contaminant levels in fish and shellfish tissues.

The results of the studies are summarized below. The total DDT levels measured in surface water from the Lauritzen, Santa Fe and lower Richmond Inner Harbor Channels were 50 ng/L, 9 ng/L, and 1 ng/L, respectively. The dieldrin concentrations were 18 ng/L, 2 ng/L, and nondetectable, respectively. These results indicate that the water quality criteria are violated in the Lauritzen and Santa Fe Channels, but are achieved (within the uncertainly of the analysis) or not detectable in the lower Inner Harbor Channel. Analysis of water-to-sediment ratios indicates that the Lauritzen is a source of contamination to the other channels.

Sediment concentrations of total DDT declined from over 50 mg/kg in the Lauritzen Channel to 12 μg/kg near Point Potrero. Dieldrin concentrations declined from 570 μg/kg in the Lauritzen to

nondetectable levels in the Inner Harbor Channel. These results are consistent with those of previous researchers, and with the more extensive RI of marine sediments (White et. al 1994).

In 28-day bioaccumulation tests using *Macoma nasuta,* tissue levels of DDT over 50 mg/kg (dry wt) and 1.5 mg/kg dieldrin were obtained using Lauritzen Channel sediments. Tissue levels declined to 80 μg/kg DDT and undetectable levels of dieldrin using sediments from the vicinity of Point Potrero. These results are consistent with those of previous researchers. Further studies revealed that the tissue concentrations obtained at 28 days were approximately half those obtained after a 90-day exposure. Tissue residues of DDT and dieldrin measured in field-collected benthic infauna were as high as 46 mg/kg and 2.5 mg/kg (dry wt), respectively, in the Lauritzen Channel. Concentrations dropped by about two orders of magnitude in the Inner Harbor Channel.

Tissue residues of DDT and dieldrin measured in mussels *(Mytilus sp.)* were 2.6 mg/kg and 97 μg/kg (wet wt) in the Lauritzen Channel, and declined to 40 μg/kg and 5 μg/kg in the lower Richmond Inner Harbor Channel. These results are consistent with those of the State Mussel Watch program. Tissue levels in the lower Inner Harbor Channel are higher than would be predicted from the underlying sediment concentration, again indicating that there is water-column transport of pesticides from the Lauritzen to less contaminated areas.

Tissue residues of DDT measured in whole fish (shiner perch) were over 10 mg/kg in the Lauritzen Channel, roughly 1 mg/kg in the Santa Fe Channel, and roughly 0.1 mg/kg in the Richmond Inner Harbor Channel. Dieldrin levels were roughly 0.6 mg/kg, 0.04 mg/kg, and 0.002 mg/kg in the respective channels. The contaminant concentrations in fish from the Lauritzen Channel are in the same range as those measured in the 1960s, and exceed the levels that may cause adverse impacts to sensitive predatory birds by orders of magnitude. A sensitive bird, which had no other source of DDT in its diet and which consumed more than 0.5% to 1.5% of its diet from the Lauritzen Channel, could be adversely affected. These concentrations may also cause direct toxic impacts such as reduced fry survival in fish. The results for the Santa Fe Channel are an order of magnitude lower, but still exceed levels that may cause adverse impacts to sensitive fish-eating birds. A sensitive bird that consumed more than 5% to 15% of its diet from the Santa Fe Channel might be adversely affected.

Sediment toxicity tests using the amphipod, *Eohaustorius estuarius,* indicated significant acute toxicity in sediments from the Lauritzen Channel. Sediments from the Santa Fe Channel displayed lower but significant toxicity relative to the amphipod's native Yaquina Bay, Oregon, sediment, but were not significantly different from those in the Inner Harbor Channel or other San Francisco Bay locations. DDT was determined to be the primary cause of toxicity in the Lauritzen Channel.

Additional toxicity tests conducted during the RI using the amphipod *Rhepoxynius abronius* confirmed the acute toxicity of Lauritzen Channel sediments. In four of five Lauritzen Channel compoSite samples, there was no survival of test organisms, an extremely rare occurrence indicating severe toxicity. Amphipod survival in samples beginning at the southern end of the Lauritzen Channel and proceeding out the harbor was not significantly different than survival in the San Francisco Bay fine-grained sediment control, indicating that the toxicity is confined to the Lauritzen.

An analysis of benthic infauna indicated that amphipod abundance (with the exception of the pollutant-tolerant *Grandidierella japonica*) was inversely related to DDT concentration. The minimum benthic ecological effects concentration was determined to be 100 μg DDT/g organic carbon (equivalent to 1.9 mg/kg, dry wt, at 1.9% organic carbon).

Overall, the results indicate that the gross contaminant levels in the Lauritzen Channel threaten a variety of ecological receptors at various trophic levels, including benthic and water-column organisms and fish-eating birds. Effects are likely to be much less severe in the Santa Fe Channel, although the contaminant levels in fish are significantly higher than the levels that may threaten sensitive fish-eating birds. In the Richmond Inner Harbor Channel, the DDT levels in fish (100 μg/kg) are between the level that is the basis of EPA's chronic marine water quality criteria intended to protect marine birds (150 μg/kg), and the National Academy of Sciences (NAS) recommendation (50 μg/kg) for protecting marine birds. It is clear from the results above that the most sensitive ecological receptors to sediment organochlorines in Richmond Harbor are likely to be fish-eating marine birds.

The only contaminated medium for which applicable regulatory criteria were identified is surface water. Nonregulatory or surrogate criteria were also identified for fish and shellfish tissues and sediments. Fortunately, surface water concentrations were found to be quite consistent during different tidal cycles and seasons in each of the three channels sampled. In addition, the concentrations measured in the water column and the concentrations measured in whole fish were found to agree remarkably with the concentrations predicted by the applicable EPA marine chronic water quality criteria. This demonstrates that total DDT present in surface waters is bioavailable, and that it accumulates as predicted by the applicable marine chronic criteria.

The analysis of surface water pesticide concentrations in the three channels indicates that the concentrations in the Santa Fe and Richmond Inner Harbor Channels are likely elevated by approximately one order of magnitude over the concentrations that would result from the respective local sediment concentrations, due to the flux of contaminated water from the Lauritzen Channel. This indicates that remediation of the Lauritzen would have beneficial effects throughout the Inner Harbor.

Site Remediation Goals. The final goal of the ecological assessment was to provide sufficient information to develop Site remediation goals for contaminated marine sediments containing the COCs, DDT and dieldrin, which would be protective of the environment and human health. The DDT and dieldrin water quality criteria are near or below the levels which can be quantified by the best laboratories. Protective levels in sediments are much more readily measureable, particularly for DDT. Although DDT and dieldrin co-occur, the DDT concentration is generally 10 to 100 times higher, and DDT was detected in sediment samples over a wider area. Sediment remediation goals, which are expected to attain protective levels for both contaminants, have therefore been established based on DDT concentration.

As indicated above, it was determined that the minimum ecological effects concentration for benthic organisms was 100 μg DDT/g of organic carbon, which is equivalent to 1,900 μg/kg (dry wt) at 1.9% organic carbon. Sediment concentrations exceeding this value might cause local chronic adverse impacts to benthic organisms. EPA has reviewed data for other DDT-contaminated Sites, and found a similar threshold for benthic effects. Sediments in the Lauritzen Channel and Parr Canal exceed this level. The maximum concentrations outside these channels are below this level.

The EPA marine chronic water quality criteria of 1 ng/L DDT is likely to be achieved if the average channel sediment concentration is below 1,000 μg/kg DDT (dry wt); and the human health criteria of 0.6 ng/L is likely to be achieved if the average sediment concentration is below 590 μg/kg DDT.

TABLE 4. Remediation Levels

Final Remediation Levels				Cancer Risk Level
Medium	Chemical	Level	Basis	
Surface Water	DDT Dieldrin	0.59 ng/l 0.14 ng/l	EPA AWQC	1×10^{-6} 1×10^{-6}
Sediment	DDT	Avg: 590 µg/kg	Ecological Assessment	1×10^{-6}

The average sediment concentrations in the Lauritzen Channel and Parr Canal exceed the 590 µg/kg DDT level, while the average concentrations in the Santa Fe and Inner Harbor Channels are below the level. Therefore the remediation of sediments will be limited to the Lauritzen Channel and Parr Canal. Although the concentrations of pesticides in upland soils are acceptable for human exposure, they exceed the protective levels for sediments in the adjacent channels, indicating that erosion of upland soils and stormwater runoff to the marine environment should be prevented.

The NAS action level for the concentration of DDT in fish to protect fish-eating birds is not an ARAR but was identified as a TBC to assist in determining the protectiveness of remediation. The NAS action level is likely to be achieved if the average channel DDT sediment concentration is below 420 µg/kg. Since the average concentrations of DDT in the Santa Fe and Inner Harbor Channels are below this level, cleanup of sediments in the Lauritzen Channel and Parr Canal is expected to result in achievement of the NAS action level.

8. Description of Alternatives.

The environmental media requiring remediation are soft marine sediments (young bay muds) in the Lauritzen Channel and Parr Canal. Contamination is confined to softer younger bay mud, and has not migrated into the underlying older bay mud. The volume of contaminated sediment in the Lauritzen Channel and Parr Canal is approximately 65,000 yd^3. Remediation of this sediment is expected to result in achievement of the remedial action goals. In addition, erosion of upland soils containing DDT at concentrations exceeding the final remediation level for sediments must be prevented. No action will be taken in other areas in Richmond Harbor, such as the Santa Fe Channel and Inner Harbor Channel, because sediment levels are below the remediation levels established above.

The action alternatives presented below all include dredging of contaminated sediments and paving of upland soils on the northern half of the Levin Richmond Terminal. The principal difference among these alternatives is in the location chosen for disposal of dredged sediments. In addition, the "no action" alternative has been retained as a baseline for comparison with the other alternatives, as required by the National Contingency Plan, 40 C.F.R. § 300.430(e)(6). The four alternatives are summarized below:

Alternative 1: no action

Alternative 2: confined disposal of marine sediment in the Port of Richmond's Point Potrero graving docks, and capping of upland areas

Alternative 3: confined disposal of marine sediment in the Lauritzen Channel, and capping of upland areas

Alternative 4: offsite disposal of marine sediment by rail, and capping of upland areas.

With the exception of "no action," all of the alternatives have been developed to meet the remedial action goals. In addition to the components listed above, each action alternative includes environmental monitoring to evaluate the effectiveness of the remedy, and institutional measures to limit future Site uses to those considered in the human health risk assessment.

Common Elements

Elements which are common to two or more alternatives, including dredging, monitoring, paving of upland areas, and institutional controls, are discussed below.

Dredging. Alternatives 2 through 4 would involve dredging of the younger bay mud from the Lauritzen Channel and Parr Canal. The total volume of these sediments is estimated to be 65,000 yd^3, although if Alternative 2 were selected, some of the most contaminated sediments would remain in place in the Lauritzen Channel within a Confined Disposal Facility (CDF). In areas to be dredged, all soft sediments down to the hard older bay mud contact would be removed.

Silt curtains would be erected across the mouths of the channels prior to dredging to prevent transport of sediment disturbed by the dredging process out of the excavation area. In addition, control measures would be implemented to prevent or minimize the runoff or return of sediment back to the excavation areas. The surface water ARARs for the concentrations of COCs are not currently achieved, and would not be expected to be achieved in the Lauritzen Channel and Parr Canal during the dredging phase of remediation at the Site. The surface water ARARs are remedial action goals which are expected to be achieved after the dredging is completed.

Two sunken barges, one small tank, and other debris (see Figure 3) would have to be removed from the Lauritzen Channel prior to dredging under Alternatives 2 through 4. In one of the configurations of Alternative 3, a CDF would be constructed in the northern end of the channel, allowing one barge and the small tank to remain in place. Samples of sediment taken by EPA divers from inside the barge and tank indicated that they are not sources of contamination.

Monitoring. In order to determine the effectiveness of the remedial action, a post-remedial monitoring program would be required. Monitoring would be expected to occur annually for at least five years or until it was demonstrated that the remediation goals had been achieved, and could continue at longer intervals (e.g., once every five years) for an additional period of time. The monitoring program would also be implemented as part of the "no action" alternative.

The post-remedial monitoring program would include surface water and biological monitoring components. Periodic collection and analysis of surface water samples would determine compliance with EPA ambient water quality criteria, which are ARARs. Bioaccumulation could be monitored through the periodic deployment and subsequent collection and analysis of mussels, as is done in the State Mussel Watch program. Mussels provide the most consistent, readily obtainable biological data. These data can be compared to the historic State Mussel Watch bioaccumulation

database for Richmond Harbor to confirm reductions in tissue residues. Sampling locations to confirm the effectiveness of the remedy would be in the Lauritzen, Santa Fe and Richmond Inner Harbor Channels. Additional sampling might be required based on the remedy selected. For example, if confined disposal at the Port of Richmond's graving docks were selected, an additional monitoring station would be established outside the facility.

Capping of Upland Area. The results of the human health risk assessment indicate that the removal actions performed at the Site between 1990 and 1993 reduced contaminant concentrations in upland soils to levels that are acceptable for current and expected future commercial or industrial uses. Nevertheless, roughly 95,000 tons of soils over a large area of the Site exceed the much lower remedial action goal for marine sediments. Therefore, a remediation goal of erosion prevention was established for upland soils. The northern half of the Levin Richmond Terminal, which is where the United Heckathorn facility was located and where concentrations exceed 1 mg/kg DDT, is currently unpaved. Each of the action alternatives includes paving this area with asphalt. The area of the upland asphalt cap is shown in Figure 6. The cost of capping this area was estimated in the FS performed by Levine-Fricke (1991). The estimate of $400,000 includes a 20% contingency. This cost is included in the estimates generated for each remedial alternative except "no action."

Institutional Controls. The human health risk assessment concluded that the concentrations of COCs in upland soils at the Levin Richmond Terminal had been reduced to acceptable levels for current and expected future industrial uses. This is consistent with the San Francisco Bay Plan under which the area is zoned for port priority or water-related industrial use. In order to provide an additional measure of assurance that the Site could not be converted to other use, such as residential, without further study and possibly further remediation, a deed restriction on the property will be included as part of Alternatives 2 through 4.

The Lauritzen Channel is currently posted with signs warning fishermen that fish and shellfish may be contaminated with DDT and other pesticides. These signs will remain in place until post-remedial monitoring confirms that concentrations of the COCs have been reduced to acceptable levels.

Alternative 1: No Action with Monitoring. The NCP requires the analysis of no action as an alternative (40 CFR 300.430(e)(6)). Under no action, no further remediation would be conducted at the Site, although the monitoring program would still be performed to evaluate the effects of the remaining contamination. The existing institutional controls would remain in place.

The no action alternative does not meet either of the two threshold criteria described below (overall protection of human health and the environment, and compliance with ARARs). Because the threshold criteria are not met, this alternative is not eligible for selection.

Alternative 2: Dredging with Containment at the Point Potrero Graving Docks. The major components of this alternative are dredging approximately 65,000 yd^3 of contaminated sediment from the Lauritzen Channel and Parr Canal, and disposing of the sediment in a CDF constructed at the Port of Richmond's graving docks.

The graving docks are located at Point Potrero, at the southern end of the Richmond Inner Harbor Channel, approximately one mile from the location of the former United Heckathorn facility (see Figure 2). A sediment containment facility constructed at the graving docks could be determined to be "onsite" under the definition of the NCP, which includes all locations within the areal extent of contamination and all suitable areas in very close proximity necessary for implementation of the response action (40 CFR 300.5).

Graving docks are concrete box structures used to drydock ships. The Point Potrero graving docks were built during World War II and, due to their relatively small size, are obsolete for modern vessels. The Port of Richmond suggested that the graving docks be analyzed as a potential disposal Site for contaminated sediments because they have the capacity to effectively contain very large volumes. Depending on the configuration and number of basins used, the facility could contain between 89,000 yd^3 and 500,000 yd^3 of sediment. The facility would not be simply a disposal Site, but would be constructed so that it would be suitable for use as a marine shipping terminal. Use of the graving docks would not be offered by the Port of Richmond for disposal alone. The Port has analyzed a number of alternative configurations which would accommodate varying volumes of dredged material and provide the Port an additional berth or pier of at least 600 ft. The Port's cost estimates for each of the various configurations include the costs of preparing the basins to receive dredged material, and the costs of enhancing the facility for Port use.

The configuration chosen for analysis would entail filling Basin 1 with approximately 65,000 yd^3 of sediment dredged from the Lauritzen Channel and Parr Canal, and 24,000 yd^3 of additional material to produce a total of 89,000 yd^3. This is the lowest cost configuration which would provide sufficient volume to contain sediments dredged from the Lauritzen Channel and Parr Canal. Prior to receiving sediment, Basin 1 would be inspected and repaired if necessary, and then sealed with a concrete bulkhead. Wick drains would be installed for dewatering. The pier between Basins 2 and 3 would be removed, and Basin 3 would be lengthened from 500 ft to 750 ft, creating a new berth for large ships.

Dredged sediment would be barged to the drydock and depoSited by mechanical means in order to minimize entrainment of water. It is estimated that consolidation of the sediment within the basin would take a minimum of four years. If hydraulic dredging were used, consolidation would probably take longer. The average concentration of DDT in the sediment would be 30 mg/kg wet wt. Based on the results of the treatability testing performed during the marine RI, it is expected that treatment by filtration and carbon adsorption would be required before effluent produced by dewatering could be discharged from the basin to the bay. Although a Waste Discharge Permit would not be required under CERCLA, substantive requirements would have to be achieved, including toxicity limits and compliance with numeric water quality criteria. A possible alternative would be to discharge effluent to a sanitary sewer under permit from the local agency. Discharges to the sewer system would be "offsite" and require permitting.

In addition to the actions described above, this alternative would include the post-remedial monitoring program, removal of the sunken barges and other debris from the Lauritzen Channel, asphalt paving of the northern half of the Levin Richmond Terminal, and institutional controls. The estimated cost of this alternative included roughly $700,000 to prepare Basin 1 and close it after filling, and roughly $1.8 million to remove the pier between Basins 2 and 3, and lengthen Basin 3 to produce a 750-ft berth. Annual overhead and maintenance costs include evaluation and repair of the graving docks, operation and maintenance of an effluent treatment system for dewatering sediment, and post-remediation monitoring. The total estimated cost for this alternative is $5.6 million. This estimate does not include the costs, which could be substantial, of obtaining an agreement among various parties regarding the use of the facility and future liability. In addition, state and federal agencies have indicated that they might seek mitigation to compensate for the fill associated with this alternative. The costs of mitigation would also significantly increase the total cost of this alternative.

This alternative would be expected to meet the remedial action goals defined in Table 4 and provide effective long-term protection of human health and the environment. It is unclear, however, whether it would comply with ARARs related to bay fill unless an upland alternative were unavailable. Dredging would cause short-term impacts within the excavation areas. Because the

dredged sediment would be classified as hazardous waste pursuant to State of California regulations, this alternative would require agreements between a number of government and private parties regarding long-term liability and operations and maintenance, limiting its implementability.

Alternative 3: Dredging with Containment at Lauritzen Canal. The major components of this alternative would be dredging between 44,000 yd^3 and 52,000 yd^3 of contaminated sediment from the Lauritzen Channel and Parr Canal, and depositing it in a CDF constructed within the Lauritzen Channel. Two variations of CDFs were analyzed for this alternative based on alternatives developed by Levine-Fricke (1991). The first consists of a steel sheetpile wall approximately 1300 ft long constructed along the eastern shoreline of the channel. The sheetpile wall would be tied to anchors placed in the soil at the Levin Richmond Terminal. This configuration does not interfere with either the storm drain at the northern end of the channel, or with properties across the channel from Levin.

The second variation of a CDF in the Lauritzen would consist of a rock dam across the northern end of the Lauritzen Channel. Advantages of this configuration are that it would minimize the dredging of the most contaminated sediments in the channel; the barge, tank, and debris in the northern end of the channel could remain in place; it would require less maintenance than a steel sheetpile wall; and it would be less costly to construct.

Dredged sediment could be depoSited in the CDF by mechanical means, or by hydraulic dredging. Consolidation of the sediment within the basin would take several years. The average concentration of DDT in the sediment would be 30 mg/kg wet wt. Based on the results of the treatability testing performed during the marine RI, it is expected that treatment by filtration and carbon adsorption would be required before effluent produced by dewatering could be discharged from the basin to the bay. Although under CERCLA a Waste Discharge Permit need not be obtained, substantive requirements would have to be achieved, including toxicity limits and compliance with numeric water quality criteria. A possible alternative would be to discharge effluent to a sanitary sewer under permit from the local agency. Discharges to the sewer system in this case would be "offsite" and require permitting.

In addition to the actions described above, this alternative would include the post-remedial monitoring program, asphalt paving of the northern half of the Levin Richmond Terminal, removal of at least one sunken barge from the Lauritzen Channel, and institutional controls. Annual overhead and maintenance costs include evaluation and repair of the CDF, operation and maintenance of an effluent treatment system for dewatering sediment; and post-remediation monitoring. The cost of dredging the sediment for this alternative would be slightly lower than the costs described for the previous alternative since some of the sediment would remain in place and transportation would not be required. The estimated cost range is $13 million for the sheet-pile wall variation and $4.3 million for the rock dam. In addition, state and federal agencies and the Port of Richmond have indicated that they might seek mitigation to compensate for the fill associated with this alternative. The cost of mitigation would also significantly increase the total cost of this alternative.

This alternative would be expected to meet the remedial action goals defined in Table 4 and provide effective long-term protection of human health and the environment. It is unclear, however, whether it would comply with ARARs related to bay fill unless an upland alternative were unavailable. This alternative would require the least amount of dredging, which would minimize short-term impacts within the excavation areas. The rock dam variation of this alternative would have an impact on adjacent property owners, which could hinder implementability. In addition, because the dredged sediment would be classified as hazardous waste pursuant to State of California regulations, this alternative would require agreements between a number of government and private parties regarding long term liability and operations and maintenance, limiting the

implementability of this alternative.

Alternative 4: Dredging with Offsite Disposal. The major components of this alternative are dredging approximately 65,000 yd^3 of contaminated sediment from the Lauritzen Channel and Parr Canal, and transportation of the sediment by rail to a permitted offsite disposal facility. Transport by rail offers several significant advantages. The Levin Richmond Terminal is a rail facility with lines running the length of the shoreline of the Lauritzen Channel. Since dredging can produce very large volumes of sediment very quickly, the limiting factor in removing sediment from the Site would be the time required to load it for transport. Watertight rail cars would be used to prevent releases during transportation. A rail car can carry 100 tons, and a single train can transport approximately 8000 tons. It is estimated that the entire project could be accomplished in about two months.

In addition to the actions described above, this alternative would include the post-remedial monitoring program, asphalt paving of the northern half of the Levin Richmond Terminal, removal of barges and debris from the Lauritzen Channel, and institutional controls. The estimated cost for this alternative is $7.3 million. Since the sediments would be transported offsite to a permitted disposal facility, long-term operations and maintenance costs are only those associated with the monitoring program and maintenance of the asphalt paving at the Site. The estimated disposal cost for this alternative includes transportation by rail and was provided by the East Carbon Development Corporation, a facility in eastern Utah which is permitted to receive non-RCRA wastes.

This alternative would be expected to meet the remedial action goals defined in Table 4, provide effective long-term protection of human health and the environment, and comply with all ARARs. Dredging would cause short-term impacts within the excavation areas. Disposal of sediments at an offsite facility would require no bay fill, and would minimize long-term maintenance costs and liabilities. Offsite disposal by rail appears to be implementable at a reasonable cost.

9. Summary of Comparative Analysis of Alternatives.

The alternatives were analyzed using the nine criteria of the NCP (see 40 CFR 300.430(f)(5)(i)). The comparative analysis with respect to each criteria is summarized below. Overall, it was determined that Alternative 4, Dredging with Off-Site Disposal provides the best balance among the alternatives with respect to the evaluation criteria.

Overall Protection of Human Health and the Environment: All of the alternatives except "no action" are expected to provide adequate protection of human health and the environment. The risks associated with the COCs are due to their current location in or near the aquatic environment. Alternatives 2 and 3 would achieve protection by isolating the contaminants from the aquatic environment in onsite confined disposal facilities which would require perpetual maintenance to ensure that contaminants were not re-released to the marine environment. Alternative 4 would achieve protection by transporting contaminants offsite.

Compliance with ARARs: The "no action" alternative would not result in compliance with ARARs. Alternative 2, confinement in the Port of Richmond's graving docks, relies on the dual purpose of the remedy to create a port facility in order to achieve consistency with the CZMA and compliance with the Clean Water Act. Alternative 3, confinement in the Lauritzen Channel, would probably not be consistent with the CZMA or the Clean Water Act unless it was determined that there was no practicable alternative. Alternative 4, offsite disposal, complies with all ARARs, and appears to be practicable.

Long-term Effectiveness and Permanence: Alternatives 2 through 4 are all expected to provide adequate long-term effectiveness and permanence. Concrete vaults and shoreline CDFs have been

used successfully at other Sites to contain contaminated sediments, although they require perpetual maintenance. Alternative 4, offsite disposal, provides the highest degree of permanence because the contaminated sediments would be stored far from the aquatic environment. Although the contaminated sediment presents an unacceptable threat to human health and the environment because of its current location which allows exposure to marine organisms and biomagnification in the food chain, the expected average concentration after dredging of approximately 30 mg/kg is well within the acceptable range for direct human exposure, and would not present a direct threat when contained in a disposal facility.

Reduction of Toxicity, Mobility, or Volume through Treatment: None of the alternatives employs treatment. Alternatives 2 through 4 meet the expectation of the NCP for containment of high volumes of waste which have relatively low contaminant concentrations. Based on the process screening conducted in the FS, treatment of the COCs in Site sediments would not be practicable. Site upland soils which contained extremely high levels of contaminants were addressed in previous removal actions.

Short-term Effectiveness: None of the alternatives would be expected to cause short-term risks to the community. The risks to workers are expected to be primarily those associated with construction, transportation, dredging, and solids handling. All of the dredging alternatives would cause short-term impacts within the excavation areas, and would remove the existing benthic communities from the bottoms of the Lauritzen Channel and Parr Canal. However, it is expected that the channel bottoms would be recolonized by more diverse populations. Alternative 4, offsite disposal, would achieve protection in the shortest amount of time.

Implementability: Alternative 4 is the most readily implementable. It would require the least amount of onsite construction and preparation, and should have no administrative impediments. Alternative 2, consolidation at the Port of Richmond's graving docks, would require a complex agreement between the City of Richmond and other parties regarding ownership, operations, and liability. Alternative 3, consolidation in a CDF in the Lauritzen Channel, would likely encounter state opposition, and could require agreements among adjacent property owners regarding loss of shoreline and access, as well as agreements with PRPs and several government agencies, including the City of Richmond, DTSC and EPA.

Cost: The estimated costs for all of the alternatives are comparable. The cost for Alternative 4, offsite disposal, while not the lowest, is the most certain. The estimated costs for Alternative 2, confinement at the Port of Richmond's graving docks, and Alternative 3, confinement at the Lauritzen Channel, would be more likely to change given the need for agreements among parties regarding ownership, maintenance and liability for facilities containing wastes exceeding state hazardous levels. The costs for construction, dewatering, effluent disposal, and hazardous waste storage are also less certain than the offsite transportation and disposal costs. In addition, the cost estimates for alternatives 2 and 3 did not include possibly significant costs for mitigation of bay fill, which had been proposed by state and local agencies.

State Acceptance: The Department of Toxic Substances Control of Cal-EPA, which is the lead state agency for oversight at this Superfund Site, agrees with the selected remedy. In addition, the San Francisco Bay Regional Water Quality Control Board and the San Francisco Bay Conservation and Development Commission also agree with the selected remedy.

Community Acceptance: Based on the comments received during the Proposed Plan comment period, it is evident that the selected remedy is acceptable to the community. No comments were received from the community opposing the selected remedy or supporting other alternatives.

10. Selected Remedy.

The selected alternative is dredging with off-site disposal. Components of the selected remedy include:

- Dredging of all soft bay mud from the Lauritzen Channel and Parr Canal, with off-site disposal by rail of dredged material.
- Placement of clean sediment after dredging.
- Capping of areas around the former Heckathorn facility, shown in Figure 6.
- A deed restriction or notice limiting use of the Levin-Richmond terminal to the current industrial classification.
- Marine monitoring to determine the effectiveness of the remedy.

The remedy will involve dredging of the younger bay mud from the Lauritzen Channel and Parr Canal. The total volume of these sediments is estimated to be 65,000 yd^3. In areas to be dredged, all soft sediments down to the hard older bay mud contact would be removed. Two sunken barges, one small tank, and other debris (see Figure 3) would be removed from the Lauritzen Channel prior to dredging. In limited areas dredging may be impractical or of limited effectiveness in removing all contaminated sediments because of obstructions such as rip-rap and capping may be required.

Silt curtains will be erected across the mouths of the channels prior to dredging to prevent transport of sediment disturbed by the dredging process out of the excavation area. Dredged material will either be loaded directly onto rail cars or stockpiled on a barge or on land to facilitate loading. Excess water, if any, produced during dredging and initial handling will be returned to the dredging area inside the silt curtains. However, control measures, such as physical separation or filtration, will be implemented to prevent or minimize the runoff or return of sediment back to the excavation areas. The surface water ARARs for the concentrations of COCs are not currently achieved, and would not be expected to be achieved in the Lauritzen Channel and Parr Canal during the remediation. The surface water ARARs are remedial action goals which are expected to be achieved after the remediation is complete.

The dredged material will be transported by rail to a permitted land disposal facility which meets the requirements of the CERCLA offsite policy. The expected average concentration of approximately 30 mg/kg, is well within the acceptable range for direct human exposure, and will not present a long-term threat at a disposal facility. Monitoring of surface water and biota will occur for at least five years or until it is demonstrated that the remediation goals have been achieved, and could continue for a longer period of time. To promote the return of flora and fauna to the dredged areas, a 1/2 foot layer of clean material will be placed after dredging. The material will not significantly alter the existing bathymetry or impede navigation. The estimated cost for the selected remedy is $7 million.

The selected remedy provides overall protection of human health and the environment, complies with ARARs, and provides the best overall balance of alternatives under the nine selection criteria of the NCP.

11. Statutory Determinations

The selected remedy is protective of human health and the environment, complies with ARARs, and is cost effective. The principal threats at the Site were addressed by removal actions. Because this remedy will result in hazardous materials remaining onsite, a review will be conducted five years after the commencement of remedial action, and every five years thereafter, to ensure that the remedy continues to provide adequate protection of human health and the environment.

12. Documentation of Significant Changes.

The proposed plan for the Site was released for public comment in July, 1994. The proposed plan identified alternative 4, dredging with offsite disposal as the preferred alternative. EPA reviewed all written and oral comments submitted during the comment period. Upon review of these comments, EPA determined that no significant changes to the remedy, as it was originally identified in the proposed plan, were necessary.

During the proposed plan comment period, the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service recommended that a layer of clean material be placed in the channels after dredging for restoration. The material would promote the return of habitat and fauna to the dredged areas. The proposed plan included the placement of clean fill in limited areas. The final remedy includes placement of a 1/2 foot layer of clean material after dredging in the Lauritzen Channel and Parr Canal. The cost of placing clean material, which would apply to all alternatives except "no action," was not included in the estimates contained in the FS or proposed plan. The estimated cost is $200,000, which increases the total estimated cost from $6.8 million in the proposed plan to $7 million for the final remedy.

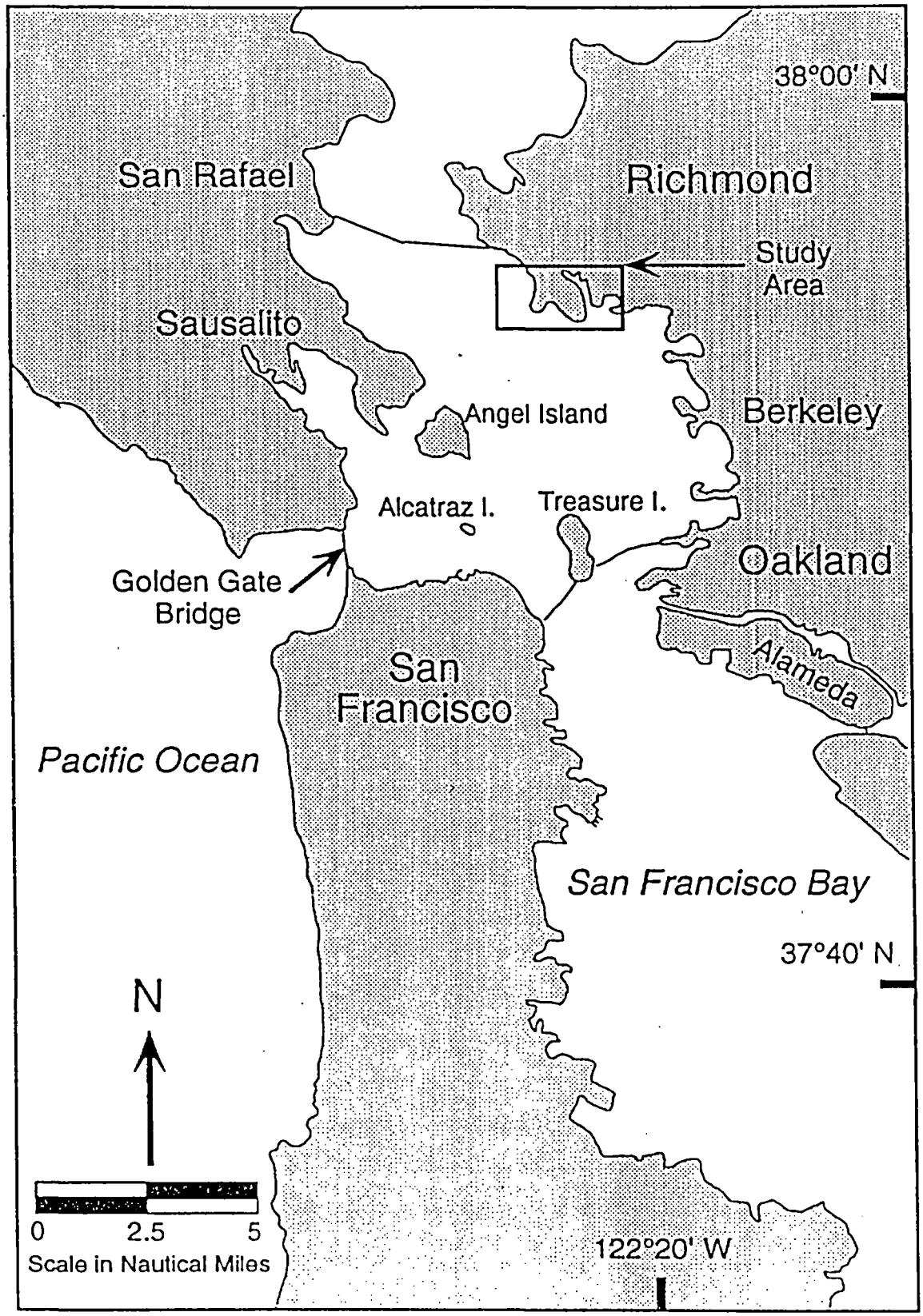


Figure 1. Site location map.

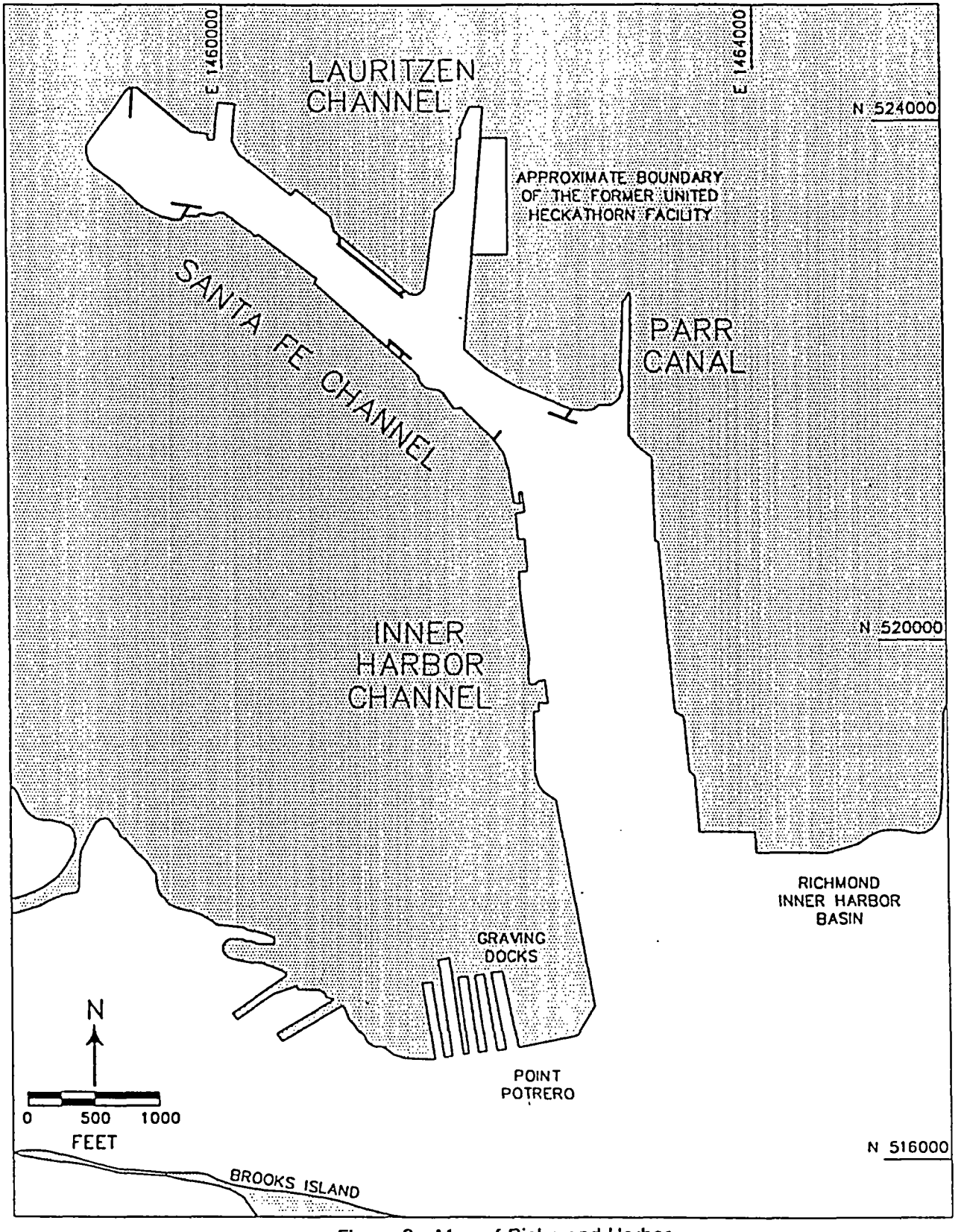


Figure 2. Map of Richmond Harbor.

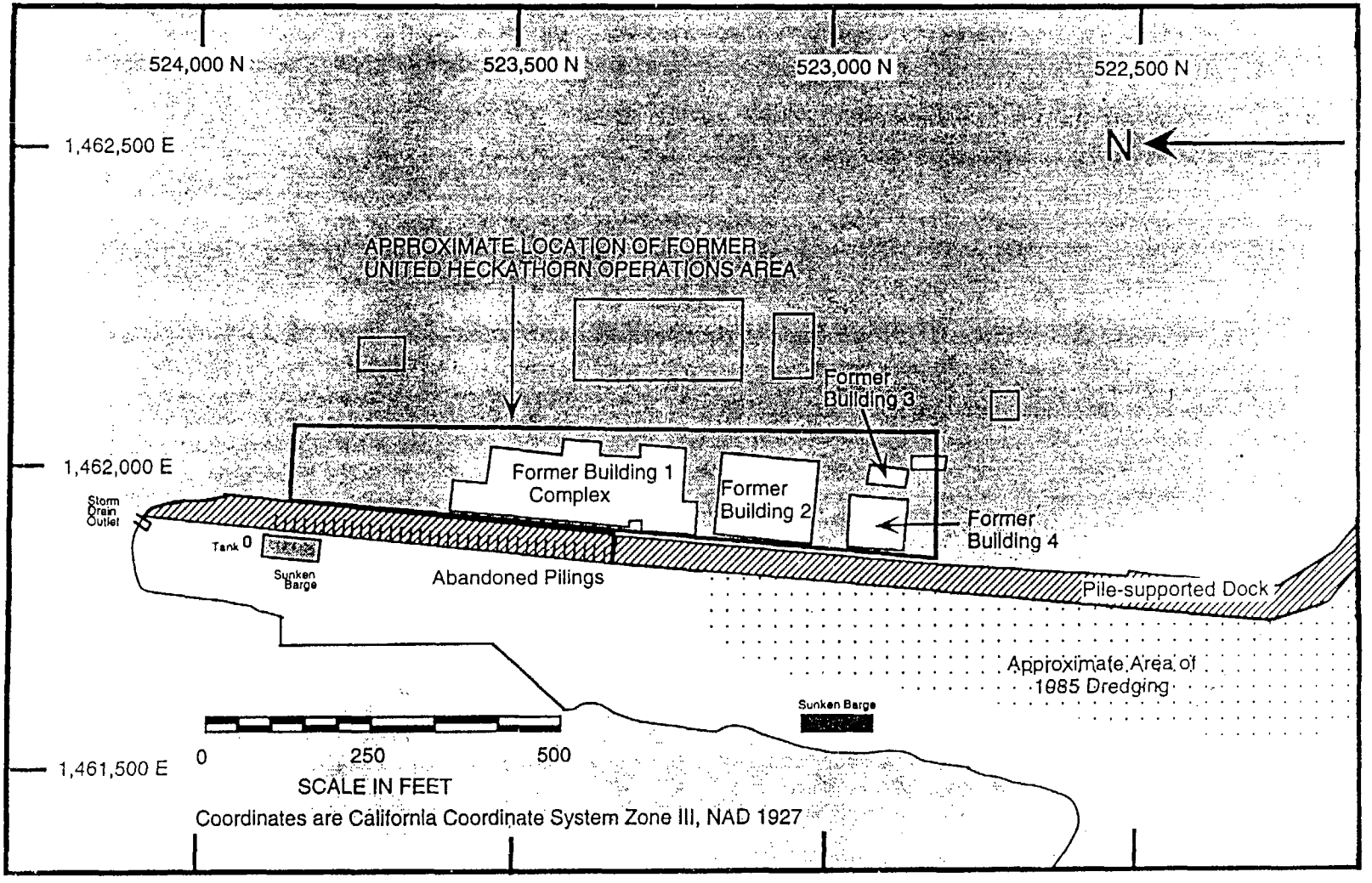
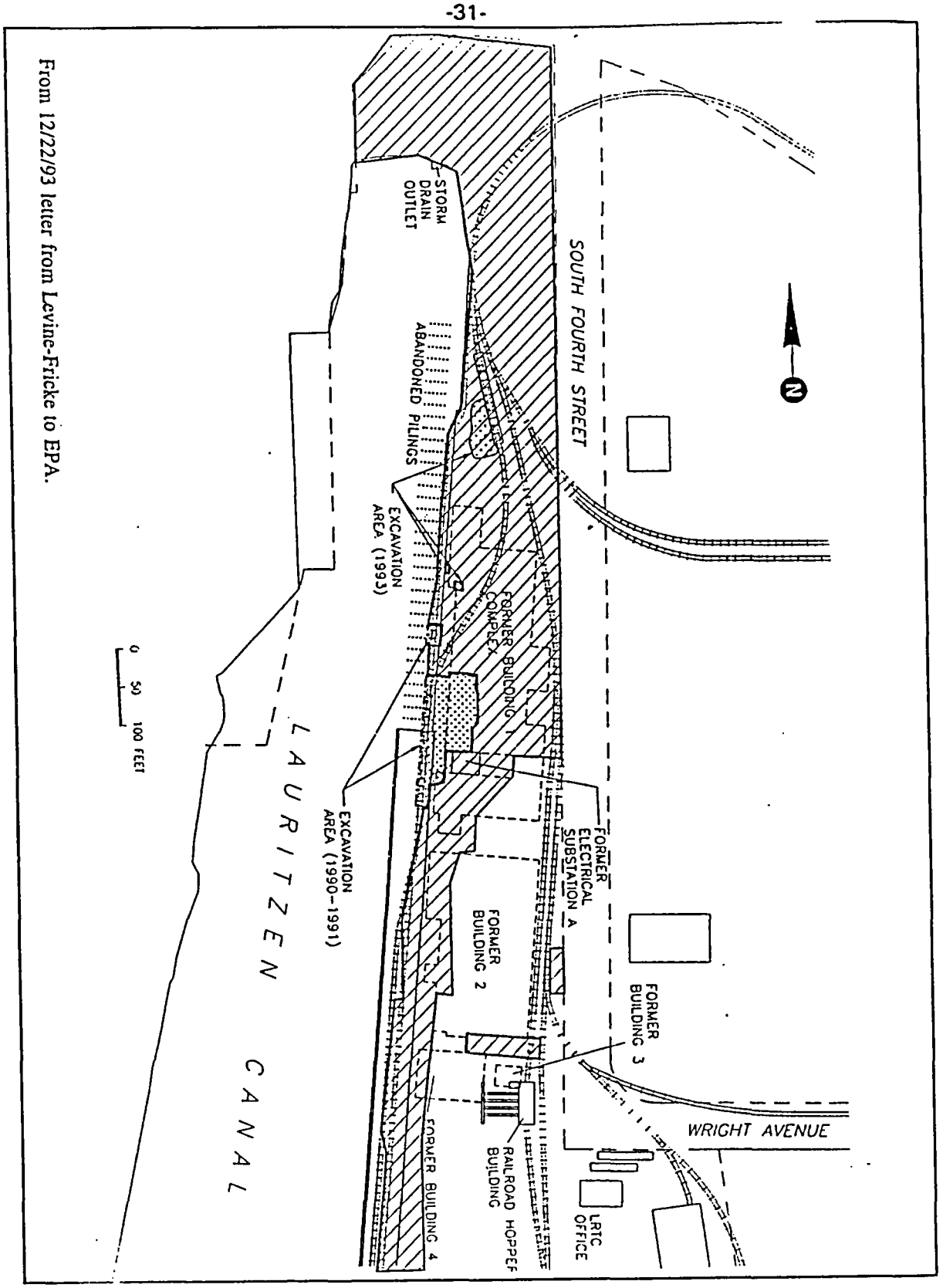


Figure 3. Map of the Lauritzen Channel.



From 12/22/93 letter from Levine-Fricke to EPA.

Figure 4. Upland soils with pesticide concentrations exceeding 1 ppm.

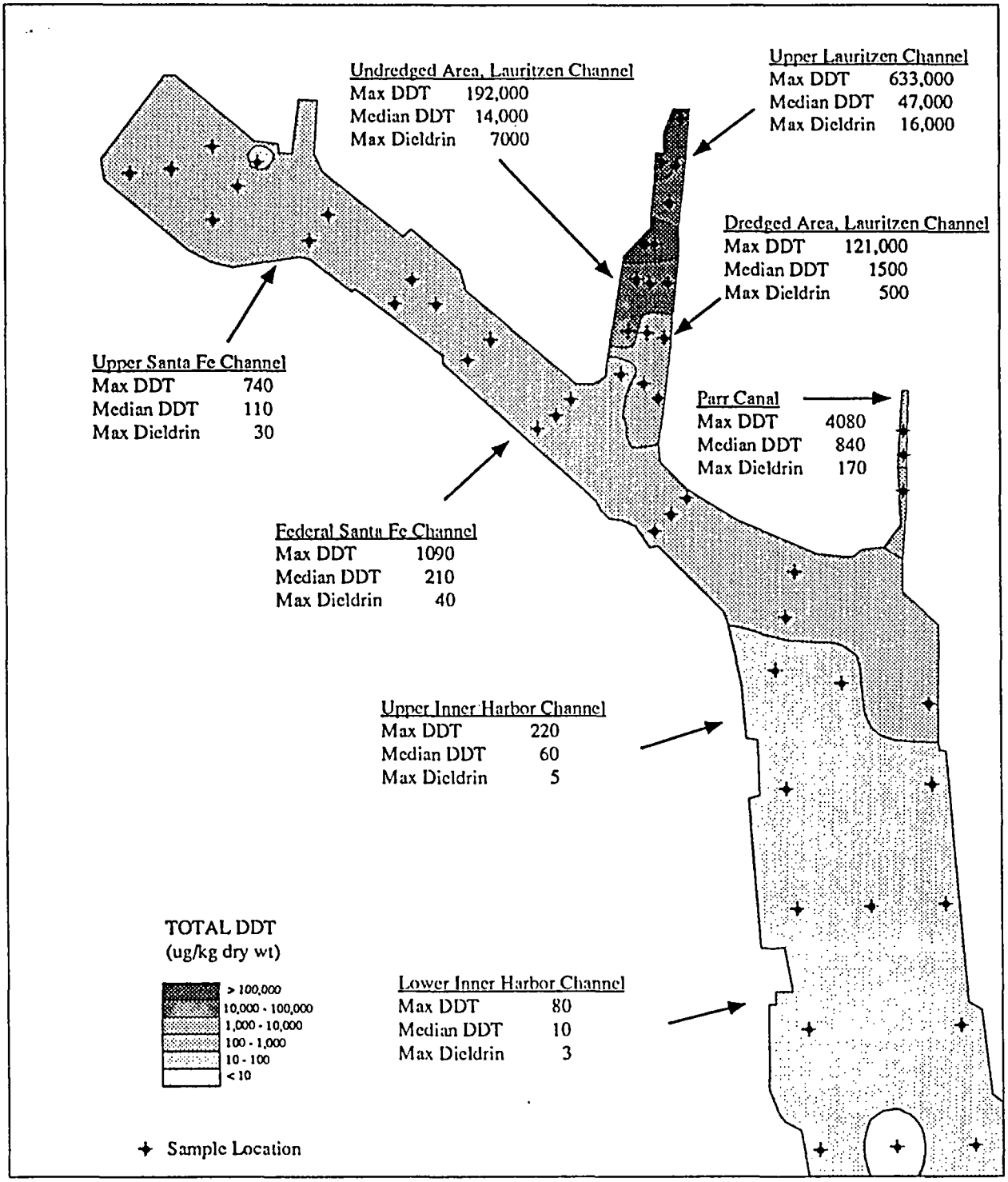
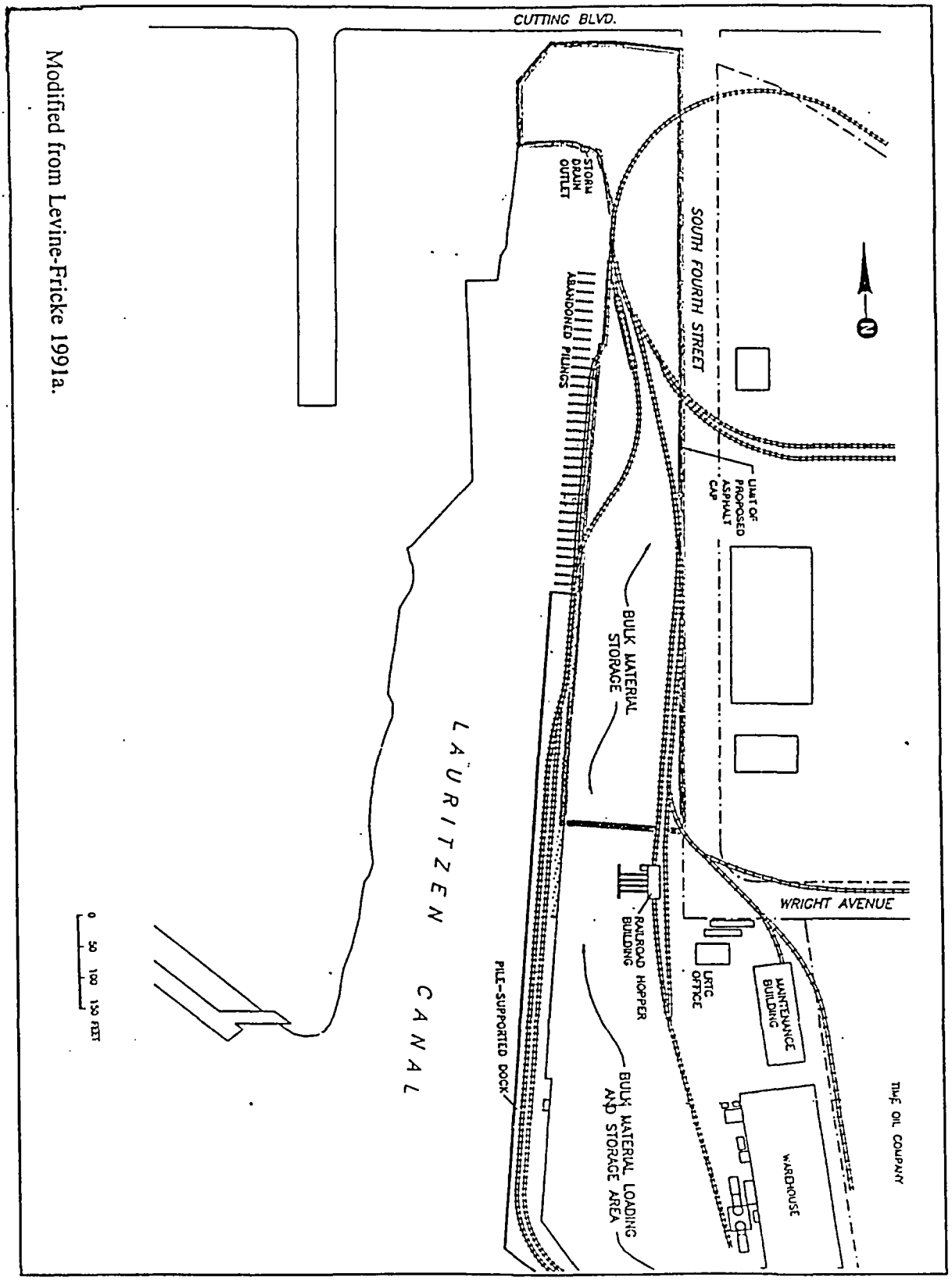


Figure 5. Average total DDT in younger bay mud, Richmond Harbor.



Modified from Levine-Fricke 1991a.

Figure 6. Limit of asphalt cap for upland soils.

RESPONSE TO COMMENTS

United Heckathorn Superfund Site
Richmond, California

October 14, 1994

EPA released the Proposed Plan for the United Heckathorn Superfund Site for public comment on July 15, 1994. The comment period included a 30-day extension which was requested by Potentially Responsible Parties (PRPs). Consequently, the public comment period closed on September 14, 1994.

Three persons made comments at the Public Hearing on August 2, 1994, one of which was also submitted in writing. Six additional written comments on the Proposed Plan were submitted during the comment period. The oral and written comments are addressed below in the order in which they were made. Two additional comments, one on the final human health risk assessment and one on the Feasibility Study, were also received during the comment period. These are discussed after the comments on the Proposed Plan.

EPA reviewed all written comments submitted during the public comment period and all oral comments made at the Public Hearing. Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, were necessary. However, a minor change has been made in response to comments from the United States Fish and Wildlife Service and the National Oceanic and Atmospheric Administration. The Proposed Plan included a provision for minor amounts of clean material to be placed in limited areas after dredging. The comments specified that six inches of clean material be placed in dredged areas to promote restoration. The ROD specifies the six-inch layer, and includes a total estimated cost for placement of $200,000, raising the final remedy cost from the proposed $6.8 million to $7 million.

1. The Bay Conservation and Development Commission stated that EPA's preferred alternative for remediation "appears to be the most consistent with the Commission's laws and policies [and] best achieves compliance with federal and state environmental laws while ensuring the protection of San Francisco Bay's diverse natural resources, and the health and safety of the surrounding human community." (letter, 7/21/94)

2. The Save San Francisco Bay Association expressed its support for EPA's Proposed Plan, stating that it "is the best way to deal with United Heckathorn's legacy of chemical contamination in the Richmond Harbor. Other proposed alternatives are unacceptable because of the need for bay fill and maintenance." (letter, 7/29/94)

3. The Director of the Port of Richmond spoke at the public hearing and also submitted his comments in writing (8/2/94). Although the Port supports the selected remedy, it is concerned that lower levels of contaminants elsewhere in the harbor may impact disposal options for material dredged for navigation purposes. The Port stated that it would hold EPA responsible for the costs of disposal of any sediments not addressed by the remedy.

Response: EPA appreciates the Port and the City of Richmond's constructive participation throughout the remedy selection process. Based on the results of the Remedial Investigation and Human Health and Ecological Risk Assessments, EPA concluded that cleanup of those channels

with mean sediment DDT concentrations above 590 ppb is necessary to protect human health and the environment. Channels and private berths outside the cleanup area may still contain sediments with DDT levels below a mean of 590 ppb or with measurable levels of other site-related and/or non site-related contaminants which might affect dredge spoils disposal options. However, based on the results of EPA's RI, HHRA and ERA, contaminant levels in sediment in the Santa Fe Channel and the Inner Richmond Harbor Channel do not pose a significant risk to human health and the environment that would trigger remediation under Superfund. Consequently, EPA in the Record of Decision for the Site has determined that no remedial action is necessary with regard to sediments in the Santa Fe Channel and Inner Richmond Harbor Channel. Under the authority established in CERCLA, particularly in Section 104(a) and Section 121, 42 U.S.C. § 9604(a) and § 9621, EPA is authorized to select remedial actions to protect human health and the environment. EPA is not authorized under CERCLA to make remedial decisions solely to redress economic or property damage that may result or may have resulted from the presence of low levels of hazardous substances or other contaminants. Should the Port incur additional dredge spoil disposal costs because of low level contamination present in the dredged sediment, the City is free to pursue any available legal remedies against parties responsible for the contamination.

4. Mr. Richard Oba, vice president of United Anglers of California spoke at the public meeting and expressed support for EPA's proposed alternative, stating, "we would like to see the job finished."

5. Ms. V. Peters spoke at the public meeting and expressed concern that EPA does not have a community public alert system already in place, stating, "should there be a railway accident, I think you really should have a plan that you can present to the community."

Response: At the time of the public meeting for a Superfund Proposed Plan, EPA has not yet selected the remedy. In this case, of four alternatives considered, three did not involve offsite transportation and disposal of waste. EPA must solicit and consider comments on all alternatives prior to making a final selection.

EPA efforts to inform and involve the community will continue throughout the period of remedial design and remedial action. A health and safety plan will be prepared and made available to the public prior to initiating any action at the site. This plan will address transportation safety and contain procedures to ensure that the dredged sediment is safely contained during transport and that if a spill occurs specific procedures will be implemented to immediately clean up the spill and minimize any risk that the community could come in contact with the spilled sediment. Transportation of the dredged sediment will be conducted by licensed transporters with oversight by EPA acting in cooperation with local and state authorities.

6. Mr. Nicholas Pinette, a resident of Richmond, stated that the preferred offsite disposal alternative makes good sense, but questioned where the dredged material would be transported to for disposal and how it would be stored. (letter, 8/7/94)

Response: EPA has not selected a particular landfill as part of this Record of Decision. The dredged material will be transported to a landfill which is permitted to receive the waste and meets the CERCLA offsite policy which requires EPA to determine that the facility is operating in compliance with all federal and state permits prior to shipment. The choice of landfill will be made by the parties who ultimately perform the remedy, subject to the determination of compliance by EPA. The contaminated sediment currently presents a threat because of its location in the marine environment, which allows direct exposure to sensitive aquatic organisms and bioaccumulation in the food chain. Once it is removed and placed in a landfill it should pose no unacceptable risks to the environment or to human health including that of workers at the disposal site.

7. The Point Richmond Neighborhood Council supported EPA's proposal for offsite disposal stating: "To move this sediment... to any other location within the City of Richmond would be an injustice to the people of the City of Richmond." (letter, 8/10/94)

8. The Montrose Chemical Corporation of California, a DDT manufacturer and Potentially Responsible Party (PRP) at the United Heckathorn Site, submitted extensive comments arguing that the proper remedy for the site is no-action. (letter, 9/13/94)

I. Without risk, no action is necessary.

Response: The contamination at United Heckathorn presents unacceptable threats to human health and the environment. These threats are summarized in Section 7 of the ROD. It should also be noted that two previous PRP-lead site investigations (Harding Lawson, 1986, and Levine-Fricke, 1991) recommended dredging the Lauritzen Channel and concluded that "no action" would not be protective of the environment.

II. EPA's Human Health Risk Assessment (HHRA) fails to demonstrate that DDT or dieldrin in sediments in the Lauritzen Channel or Parr Canal pose any significant threat to human health for the following reasons:

A. The only significant health risk calculated by EPA was for consumption of fish from the Lauritzen Channel. However, EPA has not established that fishing occurs in the Lauritzen Channel, but only in the Santa Fe Channel near the Parr Canal. The Lauritzen Channel is posted to discourage fishing. All available evidence suggests that significant exposure to fish from the Lauritzen Channel does not occur.

Response: EPA risk assessment guidance assumes that institutional controls will not be maintained, or will be ineffective in the long term in eliminating threats to human health. In addition, EPA believes that institutional controls, such as fences and warning signs, cannot be relied upon at this site to prevent fishing in the Lauritzen Channel and Parr Canal. Fish and shellfish in the Lauritzen Channel contain concentrations of DDT and dieldrin which exceed acceptable levels for human consumption. In 1986, CDHS ordered Levin to post warnings around its property, including the eastern shoreline of the Lauritzen to warn boaters about the DDT contamination in fish and shellfish. In 1991, after EPA personnel observed a person fishing from a facility on the shoreline opposite the former Heckathorn location, EPA immediately advised that facility's manager in writing about the State's 1986 health warning. Recently, the State issued a fishing advisory throughout Richmond Harbor. Signs were posted at the popular harbor fishing location near the Parr Canal where there is unrestricted shoreline access. Despite the signs, State personnel report still finding people catching fish for consumption.

B. EPA overestimated the risk from fish consumption by assuming consumption rates of 132 mg/day (sic) for subsistence fishermen and 54 mg/day (sic) for recreational fishermen.

Response: EPA's current risk assessment guidance recommends assuming consumption rates of 54 grams per day (g/day) for recreational fishermen, and 132 g/day for subsistence fishermen. Potential risks were calculated by EPA (see HHRA, Table 5-11) using standard exposure assumptions which included both the 132 g/day subsistence rate, and a much lower rate of 6.5 g/day, which was the rate assumed in the development of EPA's Water Quality Criteria for the protection of human health (1980). These criteria are ARARs at the site. The two consumption scenarios are likely to bracket current and potential future exposures. Calculated risks for consumption of fish from the Lauritzen Channel were unacceptable using either exposure assumption. Risks for consumption of fish from the Santa Fe Channel were within EPA's

acceptable risk range using the low consumption rate, but unacceptable using the subsistence rate. Therefore, EPA concluded that consumption of fish from the Santa Fe Channel may be acceptable. EPA expects that remediation of sediments from the Lauritzen Channel will reduce the concentrations of pesticides in Santa Fe Channel fish as well.

Using the responses from EPA's limited fishing survey, Montrose's consultant, Terra, Inc. (August 17, 1994) calculated a consumption rate of 27 g/day for local fishermen. As stated in the HHRA, EPA's survey was intended only to provide general information on local fishing practices. Even with a much larger survey it would be difficult to accurately quantify current, much less future, consumption rates. For these reasons EPA has included the assumptions discussed above in its risk calculations to ensure that a reasonable maximum exposure scenario is evaluated in order to ensure that EPA actions are fully protective of human health.

C. The risks calculated for fish consumption are also overestimated because they do not account for the effects of cooking. There is no evidence that fishermen eat raw fish. Cooking reduces the concentrations of DDT in fish by 39% to 74%. In addition, absent evidence that whole fish are eaten routinely, EPA should have based its risk calculation on fillets rather than whole fish. EPA guidance states that most humans consume only fillets.

Response: EPA calculated risks for consumption of both whole and filleted fish from the Lauritzen and Richmond Inner Harbor Channels. Risks for fish from the Lauritzen were unacceptable regardless of whether the fish were whole or fillets. A group of recent Laotian immigrants interviewed by EPA stated that they consume raw fish caught in Richmond Harbor. Small fish, such as shiner surf perch, are mashed whole. When fish are filleted, the carcass is also used in the preparation of soup. In order to be protective of diverse ethnic groups known to fish in Richmond Harbor, it is prudent to assume that fish may be eaten raw and that entire fish may be consumed.

The State of California has written fact sheets for fishermen to encourage practices, such as cooking and draining away fat, which will reduce contaminant concentrations. However, even the reductions in concentrations reported by Montrose would be insufficient to make fish from the Lauritzen suitable for consumption (see previous response to this comment, ICF, May 11, 1994).

D. EPA compared fish tissue concentrations with the State of California's Water Quality Objectives which were recently held invalid.

Response: The State of California's Water Quality Objectives for DDT and dieldrin were adopted on April 11, 1991. They were based upon, and are equal to EPA's Ambient Water Quality Criteria, published in 1980. The final HHRA (May, 1994) cited both EPA's criteria, and the equivalent State objectives. EPA's criteria were identified in the July, 1994 Proposed Plan and selected in the ROD as ARARs. It should be noted that although the 1991 State objectives were recently invalidated on procedural grounds, the San Francisco Bay Basin Plan (1986), designated fish and shellfish harvesting and commercial and recreational fishing as beneficial uses of all waters of San Francisco Bay, which supports EPA's determination in the Record of Decision (Section 6) that the federal Ambient Water Quality Criteria are relevant and appropriate ARARs at this site.

E. EPA's HHRA failed to cite epidemiology studies for DDT.

Response: EPA has previously responded to this comment. See final HHRA response to comments, May 11, 1994, pp.8 and 9. In addition, there is currently a great deal of research being performed on DDT and related chemicals regarding their estrogenic effects, links with breast cancer and feminization of males. Appendix 1 of this Response to Comments is a timely news article describing some of this research.

III. EPA's Ecological Risk Assessment of marine sediments (ERA) fails to demonstrate that DDT or dieldrin in sediments in the Lauritzen Channel or Parr Canal pose any significant threat to the environment health for the following reasons:

A. In identifying chemicals of concern, EPA improperly excluded from consideration chemical and physical stressors such as PAHs, PCBs, shipping disturbance and industrial activity.

Response: Physical stressors, such as shipping disturbance, were discussed and considered in the ERA, but they are neither site-related, nor are such stressors chemicals and so cannot be identified as "chemicals of concern." Non site-related chemicals, including PAHs and PCBs were also discussed and considered in the ERA. Although PAHs and PCBs are present in Richmond Harbor, they are not consistently elevated above effects thresholds or background concentrations for San Francisco Bay. By contrast, DDT concentrations in sediments in the Lauritzen Channel are on average 10,000 times higher than the San Francisco Bay background level. These facts are graphically illustrated in Figures 8, 9 and 10 of NOAA's March, 1992 evaluation of chemical contaminants in San Francisco Bay, (Technical Memorandum NOS ORCA 64) which are attached as Appendix 2 of this Response to Comments. In viewing Figure 8, it should be noted that if the vertical bar representing the concentration of DDT in the Lauritzen was drawn to the same scale as the bars representing the concentrations of DDT found elsewhere in San Francisco Bay, it would be 2,715 feet, or over a half-mile, high.

B. EPA has not shown that fish-eating birds are exposed to significant, if any amounts of DDT in the Richmond Inner Harbor. EPA did not analyze any birds or provide dose-response data for individual species. Birds are not feeding in Richmond Harbor. If fish-eating birds are not exposed, the elementary conclusion is that they are not at risk. Andrew Lincoff, Remedial Project Manager stated in a letter dated July 31, 1992 that brown pelicans only feed occasionally in Richmond Harbor.

Response: The US Fish and Wildlife Service (USFWS), which is the federal trustee for avian resources, provided EPA with a list of over 70 species of "birds known to nest in central or northern San Francisco Bay or likely to regularly feed in the immediate vicinity of Richmond Harbor." (EPA, 1994, Table 4-1). While engaged in site investigations, removal actions and other activities at the site, EPA personnel and contractors observed that numerous fish-eating birds including cormorants, western grebes, kingfishers, loons, and California brown pelicans, an endangered species, commonly feed throughout the Richmond Inner Harbor, including the Lauritzen Channel.

The Project Manager's 1992 statement that brown pelicans may only occasionally feed in the harbor was made based on the assertion in a previous PRP Remedial Investigation Report (Levine-Fricke, 1990) that no endangered species had been seen in the vicinity of the site. However, since EPA began working at the site, endangered brown pelicans have been seen commonly in the Inner Richmond Harbor. In response to repeated unsupported claims by Montrose and its consultants that birds would not be found in an industrialized harbor, EPA, with minimal effort (EPA memoranda 12/8/93 and 12/16/93), was able to observe and photograph numerous species of birds in the harbor, including an additional species of shorebird which had not been listed by USFWS. These photographs also include a group of endangered brown pelicans which were feeding at the confluence of the Lauritzen and Santa Fe Channels, and document a brown pelican in the act of plunge-diving for fish at the same location.

It is not subject to any reasonable doubt that DDT in Richmond Harbor accumulates in the food chain and that predatory birds are being exposed. In a 1985 study (Ohlendorf, 1991) the concentration of DDE (a metabolite of DDT) in surf scoters, a migratory shellfish-eating bird which winters in San Francisco Bay, was measured in 39 birds shot in January and compared with the

concentrations in 40 shot in March. The body burdens of birds wintering in Richmond Harbor increased by over four-fold in three months, clearly demonstrating that even birds which feed for only part of the year in and near the harbor can have significant bioaccumulation. No significant increases in concentration occurred in birds which wintered elsewhere in San Francisco Bay.

It is outside the scope of the EPA ecological risk assessment process to conduct new studies to determine dose response information for birds species present at the site. Furthermore, studies of higher organisms, especially birds, are not necessary because criteria are available for their protection (EPA's Ambient Water Quality Criteria and California's Water Quality Objectives) which are based upon achieving much more easily measurable contaminant concentrations in fish and the water column. The primary field sampling for EPA's United Heckathorn ecological assessment took only six days. As discussed in the assessment (Chapter 5), "studies of more mobile species, particularly migratory birds, would require much more effort and would be subject to inherently higher uncertainty regarding pollutant sources and effects than the study of sessile and relatively non-mobile organisms chosen here."

EPA assessed the risks posed by DDT to fish-eating birds using two published criteria for the protection of birds which are based upon contaminant concentrations in fish. EPA's marine chronic Ambient Water Quality Criteria for DDT (1980), which is an ARAR, is based upon a fish tissue residue of 150 ppb. This concentration is a Lowest Observed Adverse Effect Level at which reproduction in California brown pelicans was reduced to a level below that necessary to sustain a stable population. The more protective National Academy of Sciences (NAS) action level for the protection of fish-eating birds is 50 ppb (published by EPA in 1973). The concentration of DDT in fish caught in the Lauritzen Channel is over two orders-of-magnitude (100 times) higher than the NAS level. In the ERA, (Figure 9-19) EPA estimated that if a bird consumed prey from the Lauritzen for more than about one day per year, its annual average diet would exceed the NAS action level. At more than three days per year, it would exceed the level at which reproduction is reduced in pelicans. These calculations may well underestimate risk for a number of reasons, including the fact that they assume that the bird is exposed to no other source of DDT. California brown pelicans, for example, migrate during non-breeding months from nesting areas in southern California (US Department of the Interior, Final Report: California Seabird Ecology Study, MMS 87-0055) where they may be exposed to DDT contaminated prey while feeding in the southern California bight: an area still heavily contaminated from the historic discharges of PRP Montrose's former Torrance, California DDT manufacturing plant.

EPA did not report dose-response data for all species of birds likely to feed in Richmond Harbor because such data does not exist. Dose-response data is available for only a few species of wild birds, including American kestrels, mallard ducks, and a bird which does feed in the most contaminated channels in Richmond Harbor - the California brown pelican. Available effects data is routinely used in developing criteria for the protection of other aquatic organisms and wildlife. Recently, for example, the same effects data discussed above for California brown pelicans were used as the basis of the proposed Wildlife Criteria for DDT to protect fish-eating birds in the Great Lakes (58 FR 20802, April 16, 1993).

C. The ERA fails to demonstrate that sediment-contained DDT or dieldrin pose any significant risk to benthic invertebrates. The diversity indices for the benthic community structure and number of mollusks actually increase with concentrations of DDT. The poorest community structure was observed at locations with the lowest concentrations of DDT. The predominant effect on benthic community structure is shipping disturbance which the ERA fails to consider as a stressor.

Response: There is ample evidence that DDT contamination in the Lauritzen Channel poses a significant risk to benthic invertebrates. Invertebrate toxicity tests conducted during the ERA indicated that Lauritzen Channel sediments are among the most toxic ever tested by the EPA personnel who developed the standard methods for sediment toxicity tests which are used worldwide. The extraordinarily high levels of DDT were determined in the ERA to be the primary cause of toxicity in the Lauritzen. Additional invertebrate toxicity tests conducted during the RI (Battelle, 1994) found no survival of test organisms throughout most of the Lauritzen Channel.

Although disturbances relating to shipping (including dredging to maintain required depths for navigation and propeller wash from ships) can remove or displace benthic organisms, it does not follow that chemical contamination of the benthos is acceptable. The Richmond Harbor federal channel is dredged annually to maintain a 35 ft navigation depth. The federal channel runs from Point Potrero up the Richmond Inner Harbor and lower Santa Fe Channels, but does not enter the Lauritzen Channel. There is one shipping berth at the mouth of the Lauritzen, which PRP Levin has been unable to dredge since 1985 because of the DDT contamination. Large ships cannot enter the shallower northern Lauritzen Channel which is not maintenance dredged. Absent the very high levels of DDT in the Lauritzen one would expect, based on shipping and dredging history, to find healthy benthic communities there and poorer communities in the navigation channels.

The diversity, number and biomass of mollusks are in fact lower in the shipping channels and increase in the northern Lauritzen, as would be expected from the dredging and shipping history, and the fact that mollusks are known to be insensitive to DDT. The number of amphipods, on the other hand, is opposite of what would be expected from dredging and shipping disturbances, and declines in the Lauritzen Channel because of the DDT (EPA, 1994). Amphipods are crustaceans, which are known to be sensitive to DDT. In the development of the federal water quality criteria for DDT (EPA, 1980), a crustacean was found to be the most sensitive marine aquatic organism. The sensitivity of crustaceans to DDT may be explained by their phylogentic affinity with insects (both are in the phylum Arthropoda, and DDT's purpose was to eradicate insects). An overall measure of benthic community structure is the Infaunal Index, which is a composite measure of the abundance of pollutant-sensitive and pollutant-tolerant taxa. The Infaunal Index declines significantly as DDT concentrations increase in Richmond Harbor.

Finally, it should be emphasized that even though some taxa, such as mollusks, can survive in areas like the Lauritzen which are heavily contaminated with DDT this does not mean that there is no biological effect resulting from their exposure. The California State Mussel Watch found that by far the highest levels of DDT bioaccumulation in the State occur in the Lauritzen. Bioaccumulated contaminants can move up the food chain and affect animals at higher trophic levels. The levels of DDT in benthic invertebrates, like those in fish, are far above the dietary levels which may cause reproductive impacts to birds.

D. The ERA fails to provide the required uncertainty analysis.

Response: Uncertainties relating to a myriad of factors are discussed throughout the ERA, consistent with EPA guidance. Those study results and conclusions about which there is the least uncertainty are listed in the executive summary.

E. The ERA offers no evidence that fish are being affected by DDT or dieldrin.

Response: EPA's 1980 Ambient Water Quality Criteria document for DDT reported that levels of 3 to 6.25 ppm DDT caused reduced survival in the fry of fish tested. The average concentration of fish caught in the Lauritzen is above these levels. Therefore one of the conclusions of the ERA was that the concentrations of DDT in the Lauritzen "may also cause direct chronic effects such as

reduced fry survival in fish." Montrose's complaint stems from the fact that the fish caught in the Lauritzen (mostly shiner surf perch) are not the same species as those which have been used in research. In order to determine the level of DDT which causes reduced fry survival in shiner perch, it would be necessary to start a research project, which, as Montrose also points out, is not the purpose of ecological assessments. The ERA reported numerous species of fish potentially affected by the contamination in Richmond Harbor. Since one cannot assume that the few species which have been tested are likely to be the most sensitive to the toxic effects of DDT, it would be prudent to divide the values for tested species by a factor of 10 or more to account for the uncertainty in extrapolating toxicity data from test species to those fish found in Richmond Harbor . Using this approach, one would conclude that fish in the Santa Fe Channel as well as the Lauritzen may suffer chronic impacts from current levels of DDT contamination.

F. National Academy of Sciences (NAS) action levels should not be used to demonstrate risk in an ecological assessment because they're not ARARs and do not even qualify as to-be-considered material because NAS is not a state or federal agency. NAS action levels only assume that effects will occur, EPA has not demonstrated that actual effects have occurred. EPA failed to follow NAS sampling recommendations and should have sampled fish from a variety of locations throughout known foraging ranges.

Response: The National Academy of Sciences action levels were published by EPA as 1972 Water Quality Criteria. The criteria for DDT states:

> "It is recommended that DDT concentrations in any sample consisting of a homogenate of 25 or more fish of any species that is consumed by fish eating birds and mammals, within the same size range as the fish consumed by any bird or mammal, be no greater than 50 µg/kg of the wet weight."

EPA analyzed a total of 23 shiner surf perch from the Lauritzen Channel in the ERA and in support of the HHRA. The average concentration was 9,200 µg/kg (wet weight), which is over 180 times the NAS action level. Assuming that the two additional fish needed for a sample of 25 contained no DDT, the average would still be 170 times the action level. Looked at another way, even if sufficient time and resources were spent to determine the foraging ranges of the various species of fish-eating birds which feed in Richmond Harbor and to sample fish throughout those ranges, the concentration of DDT in the Lauritzen Channel is so high that a single fish would cause a homogenate of 25 or even 170 fish of equal size to exceed the action level, even if the all of the fish in the rest of the foraging range contained no DDT at all.

In regard to the assertion that the NAS action level only *assumes* that damage will occur from DDT exposure, Montrose, a DDT manufacturer, should recall that DDT was responsible for great reductions in populations of predatory birds over vast areas and the almost complete extirpation of some species. The California brown pelican is endangered because of exposure to DDT (EPA, 1994).

In regard to EPA's not sampling birds or documenting actual damage in this study, it should also be remembered (in addition to the responses to this issue in previous comments) that the purpose of risk assessments is to evaluate risk, not to document or quantify damage. There is ample evidence that the high levels of DDT in Richmond Harbor threaten a variety of ecological receptors at various trophic levels including benthic and water column organisms and fish-eating birds. The benthic community structure analyses in fact are evidence of damage. EPA guidance recommends that when criteria exist, ecological assessments should include monitoring to determine the extent to which those criteria are exceeded by the environmental concentrations at the site. EPA has done this with the NAS action levels.

III. In the absence of risk, ARARs are irrelevant. EPA's Water Quality Criteria are not ARARs because they are not promulgated. CERCLA §121(d)(2) states that EPA criteria may be relevant and appropriate considering "the designated or potential use of the surface or groundwater, the environmental media affected, the purposes for which such criteria were developed, and the latest information available." Since the criteria for DDT was set to protect fish-eating birds, and birds are not feeding in the Richmond Inner Harbor the "potential use" of the surface water and the "environmental media affected" do not warrant application of the criteria.

Response: Risks to human health and the environment have been discussed at length above. Section 121(d)(2)(A)(ii) of CERCLA requires that remedial actions meet federal Water Quality Criteria established under Section 304 or 303 of the Clean Water Act where such WQC are determined by EPA to be relevant and appropriate to remedial actions at the site. See 42 U.S.C. § 9621(d)(2)(A)(ii) and 40 C.F.R. § 300.430(e)(2)(i)(G). In evaluating whether specific WQC are relevant and appropriate to remedial actions at Superfund site, CERCLA requires EPA to consider four criteria: 1. the uses of the receiving water body; 2) the media affected; 3) the purposes of the criteria and 4) current information. See 42 U.S.C. § 9621(d)(B)(i). See also U.S. EPA, CERCLA Compliance with Other Laws Manual - CERCLA Compliance with the CWA and SDWA (OSWER Pub. 9234.2-06/FS, Feb. 1990).

EPA guidance concerning determinations that WQC are relevant and appropriate to remedial action at a Superfund site provides that:

> A water quality criteria component for aquatic life may be relevant and appropriate when there are environmental factors that are being considered at a site, such as protection of aquatic organisms. With respect to the use of water quality criteria for the protection of human health, levels are provided for exposure both from drinking the water and from consuming aquatic organisms (primarily fish) and from fish consumption alone. Whether a water quality criterion is appropriate depends on the likely routes of exposure.

U.S. EPA, CERCLA Compliance With Other Laws Manual: Interim Final at 1-15 (EPA 540-G-89-006, Aug. 1989).

Both the marine chronic and human health WQC for DDT and dieldrin are relevant and appropriate to remedial actions at this site since both aquatic and wildlife and humans may be exposed to these contaminants either directly or through consumption of contaminated organisms. As discussed in the Ecological Risk Assessment, aquatic organisms are present in all channels at the site, which are a part of San Francisco Bay. Fish eating-birds feed in all channels in the harbor. In fact, the particular bird upon which the marine chronic water quality criterion for DDT was based is the California brown pelican, an endangered species, which has been observed feeding in the most contaminated channels at the site. As discussed in the Human Health Risk Assessment, fishermen catch and consume fish from the Inner Richmond Harbor channels. In 1986, the State of California Department of Health Services ordered the posting of the Lauritzen Channel to warn fishermen of the fish and shellfish contamination. On April 7, 1994, the Cal-EPA Department of Toxic Substances Control issued an advisory against consuming any resident bottom fish, such as white croaker, from anywhere in the Inner Richmond Harbor.

The beneficial uses designated by the State of California for central San Francisco Bay waters, which are listed in Section 6 of the Record of Decision, include fishing, wildlife habitat, preservation of rare and endangered species, fish migration, fish spawning, shellfish harvesting, and estuarine habitat. EPA's Ambient Water Quality Criteria were specifically developed to protect such beneficial uses.

IV. Background risks to human health and the environment from other stressors exceed the purported risks associated with DDT and dieldrin. The human health risk associated with PCBs found in fish exceed the risks of DDT and dieldrin. Other environmental stressors, including PAHs, PCBs and shipping disturbance are relevant to evaluating the long-term effectiveness of the chosen remedy. If the remedy will not reduce existing risk then it should be rejected in favor of no action.

Response: Both natural and anthropogenic background risks are common at Superfund sites and EPA guidance (EPA/540/1-89/002) states that they may be eliminated from risk assessments. The guidance also allows, however, that they may be considered separately in order to provide information to those potentially exposed. This was done for PCBs in the United Heckathorn risk assessment. As a result of EPA's sampling and risk analysis, the California Department of Health Services conducted a further study of fishing in Richmond Harbor and recently issued an advisory for the entire harbor based on both the Heckathorn contaminants and PCBs.

Recent research suggests PCBs may be present in the water throughout San Francisco Bay. EPA's fish sampling found that PCB mixture Aroclor 1254 is present in fish in Richmond Harbor. There is no cancer potency data available for Aroclor 1254. Therefore risks associated with PCBs were calculated using the potency factor for Aroclor 1260 which likely has higher potency. The human health risks associated with PCBs in fish from Richmond Harbor may be overstated for this reason alone. In addition, absent the distinction between Aroclors 1254 and 1260, Montrose's consultant Terra, Inc. stated that it had independently derived a potency factor for PCBs which indicated that human health risks from PCBs were overstated by "1-2 orders of magnitude." Nevertheless, the human health risk assessment still found that the risks calculated for the sum of site-related chemicals of concern (DDT and dieldrin) in the Lauritzen Channel were 2 to 3 times the risk for PCBs (ICF, 1994, Table 5-11). It should also be noted that fish in the Lauritzen exceed the Food and Drug Administration Action Levels for DDT and dieldrin, but not for PCBs. In the Santa Fe Channel, the calculations indicate that PCBs become a greater human health risk than site contaminants, but again the risk from PCBs may be overestimated.

The selected remedy will remove contaminated sediments from the Lauritzen Channel and Parr Canal and reduce human health risks from DDT and dieldrin exposure throughout Richmond Harbor. The sediments to be remediated also contain non site-related chemicals, including PCBs, although the levels of these contaminants relative to bay background concentrations is minute compared to the relative levels of DDT (see Appendix 2). Nevertheless, since the remedy will result in the removal of PCBs from portions of Richmond Harbor, there may be a reduction in human health risk associated with PCBs as well.

Other environmental stressors have been discussed in previous responses. DDT is the primary cause of toxicity in the Lauritzen Channel, and existing threats to benthos, water column organisms, and fish-eating birds are expected to be eliminated by the selected remedy.

V. Selection of the No-Action alternative is consistent with CERCLA, the NCP, and EPA guidance.

Response: EPA disagrees. As discussed in the Record of Decision, the no-action alternative fails to meet the NCP's threshold criteria for remedy selection. In addition, as mentioned previously, it should be noted that two previous PRP-lead site investigations (Harding Lawson, 1986, and Levine-Fricke, 1991) also recommended dredging the Lauritzen Channel and concluded that "no action" would not be protective of the environment.

9. The National Oceanic and Atmospheric Administration (NOAA), which is the federal trustee for marine resources, submitted comments (September 14, 1994) supporting EPA's proposed plan. NOAA also recommended: 1) not dredging during the Pacific herring spawning season (December 1 to March 1); 2) the evaluation of dredging techniques to minimize resuspension and avoid spillage during transportation; 3) various types of remedial and post-remedial monitoring, and; 4) the placement of approximately six inches of clean material over dredged areas to help restore the area immediately after implementation of the remedy. (letter, 9/14/94)

Response: EPA appreciates the information provided by NOAA and will ensure that the remedy is not implemented between December 1 and March 1. The detailed selection of dredging and monitoring techniques will be made during the remedial design phase and EPA looks forward to NOAA's participation in that process.

Several commenters before and during the comment period recommended the placement of clean material as part of the remedy. Morrison-Knudsen, consultant to Montrose, recommended the placement of clean material in areas, such as those with rip-rap, in which dredging would be impractical or of limited effectiveness. USFWS (see comment 10, below) recommended placement of clean material after remediation to bury any remaining contaminants and help restore habitat.

The Proposed Plan stated: "Minor capping, which would not significantly alter the existing depths of water, might also be used if determined to be necessary during the remedial design or remedial action phases," although a cost for this activity was not estimated. EPA has contacted Manson Construction, which provided estimates of dredging costs used in the Feasibility Study. Assuming that the total area of the Lauritzen Channel and Parr Canal is 50,000 square yards, a six-inch layer would require approximately 8000 cubic yards of clean material. Manson indicated that the cost of placement is relatively high, and estimated $25 per yard total. A six-inch layer of clean material would therefore cost approximately $200,000. This cost has been added to the estimate for the final remedy, bringing the total estimate to $7 million. There may also be an opportunity to save costs and obtain appropriately sized clean dredged material from the Richmond Harbor deepening project.

Other Comments

10. The US Fish and Wildlife Service submitted comments, dated August 15, 1994, on the FS. USFWS supported EPA's preferred alternative, and made the following recommendations: 1) removal of the upper layer of old bay mud to ensure that median DDT levels are below a deleterious effects range; 2) placement of a clean layer of fill after dredging (discussed in comment 9, above), and; 3) hazing to prevent seabirds from entering the dredging area during remediation. (letter, 8/15/94)

Response: The placement of clean fill after dredging has been discussed above. Additional recommendations regarding activities during remediation will be considered in the remedial design phase, in which USFWS is encouraged to participate. The proposed remedy including dredging of all soft sediments down to the Old Bay Mud contact. In practice, this will result in the removal of the top layer of old bay mud. Sampling conducted during the RI indicates that the medial concentration of contaminants in the upper layer of old bay mud is well below the range which may be deleterious to benthic organisms.

11. Montrose also submitted comments dated August 17, 1994 from its contractor, Terra Inc., on the final human health risk assessment. With the exception of the following comment, Terra's comments were either repeated in Montrose's comments on the proposed plan, discussed above, or were responded to in earlier responses to comments on the draft human health risk assessment. Exposure point concentrations were improperly estimated for upland soils resulting in the overestimation of risk. Due to its overstatement of risk, the final risk assessment cannot be reliably used to develop remedial alternatives or to determine whether there is any necessity to remediate surface soils.

Response: This comment ignores both the conclusions of the risk assessment and EPA's proposed remediation. The EPA human health risk assessment clearly states that conservative estimates were used, and that risks due to exposure to contaminates in upland soils are within EPA's acceptable risk range even using these conservative estimates. EPA has proposed no further remediation to reduce the concentrations of contaminants in site soils. Therefore, the entire discussion of whether the risk estimates for soils are overly conservative is moot.

Two tables in the final risk assessment (Tables 3-2 and 3-3) did in fact contain typographical errors. Corrected tables enclosed with a memo from ICF are provided as Appendix 3 of this Response to Comments. Because none of the risk calculations contained in the assessment were derived from the erroneous values, the errors had no effect on the final conclusions.

United Heckathorn Response to Comments

Appendix 1

San Francisco Chronicle, October 4, 1994
p. A9

Clue in Pesticide Link to Breast Cancer

Exposure to some poisons raises level of 'bad' estrogen

Associated Press

New York

Researchers trying to explain the disturbing link between pesticides and breast cancer have discovered that pesticides appear to raise levels of a harmful form of estrogen.

The finding comes as a surprise to the director of the research, who undertook the study expecting to show that pesticides had no effect on estrogen.

"I was wrong," said H. Leon Bradlow, a biochemist with the Strang Cancer Prevention Center at Cornell University Medical School. The study showed that after exposure to pesticides, "your risk ratio is greater than what it was before," Bradlow said yesterday.

Several earlier studies have linked pesticides to an increased risk of breast cancer, although one study failed to find a link. The new study shows how pesticides may be exerting a harmful effect, Bradlow said.

Penelope Fenner-Crisp, a pharmacologist and pesticide specialist with the Environmental Protection Agency, said the EPA is taking the link between pesticides and hormones very seriously. "We should think about how we might go about encouraging exposure reduction," she said.

The study, which will be published soon in Environmental Health Perspectives, a journal of the National Institute of Environmental Health Sciences, builds on Bradlow's previous research showing that there is a "good estrogen" that protects against breast cancer and a "bad estrogen" that is associated with increased risk of the disease.

The researchers exposed human breast cells in the test tube to DDT and other chlorine-containing pesticides. They found that the pesticides' effect on bad estrogen was three to four times as great as that of a known human carcinogen that was used as a comparison.

In a separate study, Bradlow and his colleagues found that women who eat "cruciferous" vegetables — broccoli, cauliflower, brussels sprouts and cabbage — appear to counteract the harmful effects of pesticides. An anti-cancer substance found in these vegetables called indole-3-carbinol was found to increase the ratio of good estrogen to bad estrogen.

Bradlow said a woman who eats such vegetables regularly could significantly reduce her risk of breast cancer, although he cannot yet say precisely how much lower the risk would be.

United Heckathorn Response to Comments

Appendix 2

NOAA Technical Memorandum NOS ORCA 64
Figures 8, 9 and 10

NOAA Technical Memorandum NOS ORCA 64

AN EVALUATION OF THE EXTENT AND MAGNITUDE OF BIOLOGICAL EFFECTS ASSOCIATED WITH CHEMICAL CONTAMINANTS IN SAN FRANCISCO BAY, CALIFORNIA

Seattle, Washington
March 1992

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Ocean Service

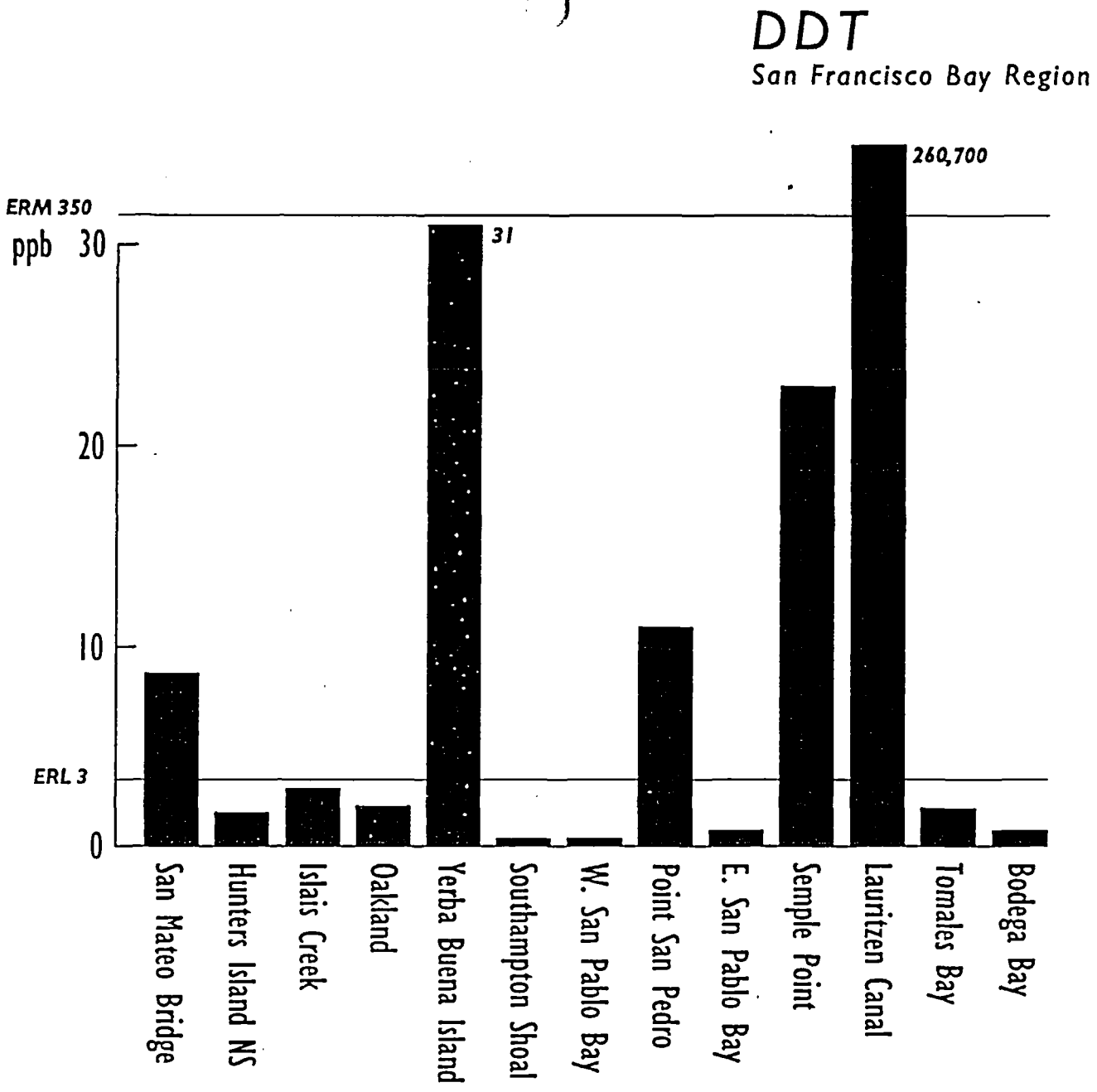


Figure 8. Mean tDDT concentrations at specific sampling sites in San Francisco Bay (from Long et *al.*, 1988) and ERL and ERM values for tDDT (from Long and Morgan, 1990).

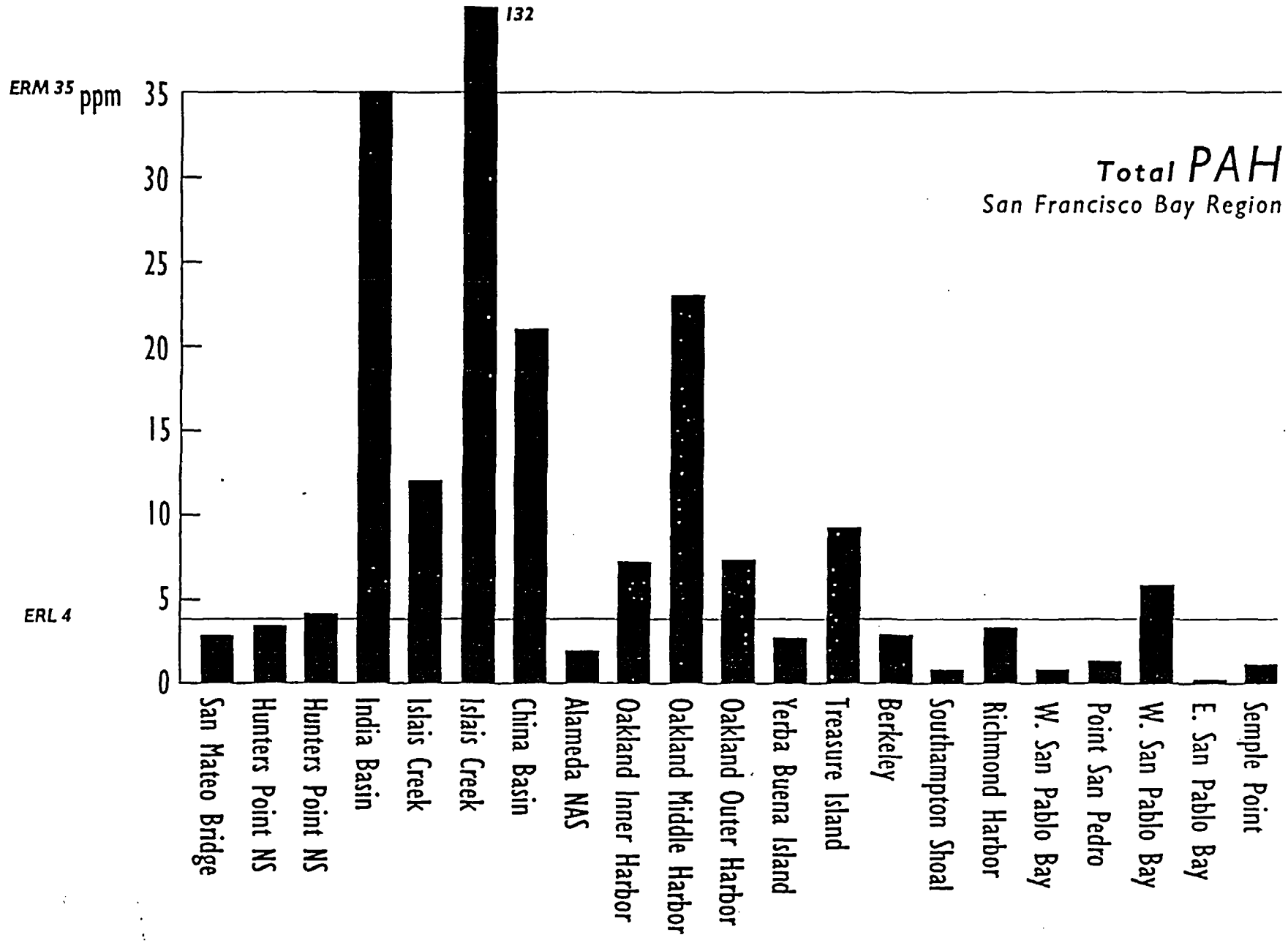


Figure 9. Mean tPAH concentrations (sum of 18 compounds) at specific sampling sites in San Francisco Bay (from Long *et al.*, 1988) and ERL and ERM values for tPAH (from Long and Morgan, 1990).

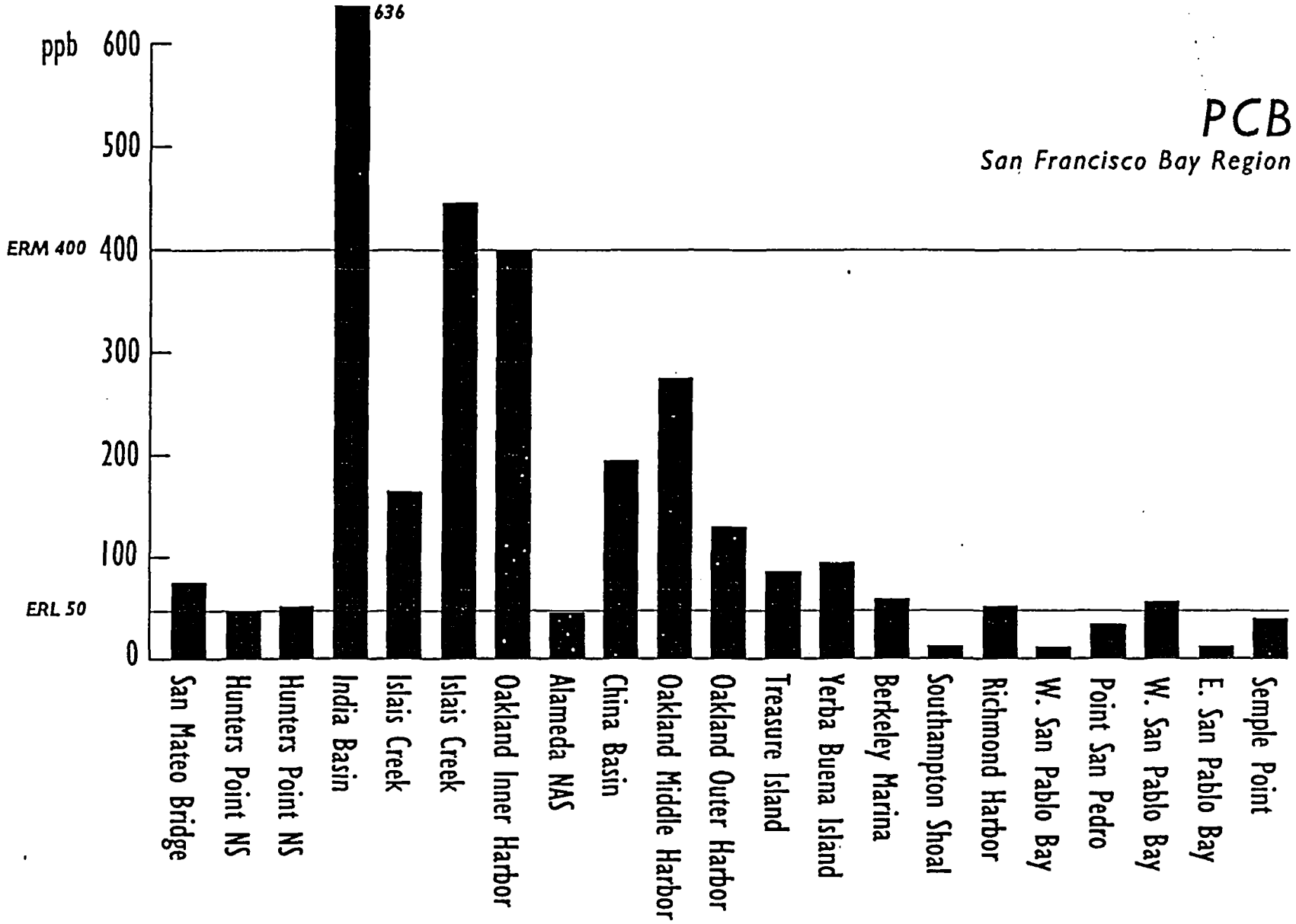


Figure 10. Mean tPCB concentrations at specific sampling sites in San Francisco Bay (from Long et al., 1988) and ERL and ERM values for tPCB (from Long and Morgan, 1990).

United Heckathorn Response to Comments

Appendix 3

ICF Kaiser Engineers Memorandum
September 7, 1994

1800 Harrison Street
Oakland, California
94612-2321

510/419-6000

ICF TECHNOLOGY INCORPORATED

MEMORANDUM
September 7, 1994

TO: **Andy Lincoff**

FROM: **D. Wayne Berman** DWB

RE: **Corrections to the final, "Human Health Risk Assessment for the United Heckathorn Superfund Site, Richmond, California."**

In response to the August 17, 1994 comments from Terra Inc. concerning the values reported in Tables 3-2 and 3-3 of the risk assessment report, it appears that a few minor typographical errors were in fact committed. Corrected tables are attached.

First, regarding the column in Table 3-2 in which 95% UCLs are supposed to have been reported, an incorrect direction command in the underlying spreadsheet to the table resulted in the RME exposure point concentrations being repeated in this column rather than the UCLs.

Note that, in no case are the correct UCLs equal to the corresponding maximum detected values, which are reported in the next column of the table. In some cases the correct UCLs are greater than the maximum detected values but this is not unusual for small or highly variable data sets, particularly when the data are adequately described by a lognormal distribution. Because none of the subsequent calculations performed to complete the risk assessment are based on the UCLs reported in this column, no material changes in the risk assessment resulted from this typographical error.

Regarding the column in Table 3-3 in which RME exposure point concentrations in soil were supposed to have been reproduced, a similar direction error in the underlying spreadsheet caused the 95% UCLs to be reported in this column rather than the RME values. Correcting this column of this table changes a small number of other values in this table; however the changes are minor and none of them affect the overall conclusions drawn from this table. Because none of the other calculations in the rest of the risk assessment are derived from the values reported in the corrected column of Table 3-3, no material changes in the risk assessment resulted from this typographical error.

Please call me if you have any further questions concerning these corrections.

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TABLE 3-2
ESTIMATED EXPOSURE POINT CONCENTRATIONS IN SOIL[1]

COC	Simplified Maximum Likelihood Estimate of the Arithmetic Mean[2] (mg/kg)	Coefficient of Variation (mg/kg)	95% UCL[3] (mg/kg)	Maximum Detected Value (mg/kg)	RME Exposure Point Concentration[4] (mg/kg)
Surface Soil (less than equal to 1 foot)					
Aldrin	9.0E-02	15.46	6.6E-01	4.1E+00	6.6E-01
4,4'-DDD	1.1E+01	13.90	3.5E+01	5.3E+01	3.5E+01
4,4'-DDE	1.4E+01	21.49	5.6E+01	7.8E+01	5.6E+01
2,4'-DDT	4.8E+01	32.23	4.4E+02	1.2E+02	1.2E+02
4,4'-DDT	1.6E+02	34.29	7.9E+02	7.0E+02	7.0E+02
DDT (total)[5]	1.8E+02	25.79	7.7E+02	7.4E+02	7.4E+02
Dieldrin	2.3E+00	60.50	1.7E+02	1.7E+01	1.7E+01
Endrin	4.6E-02	8.44	4.8E-01	1.2E-01	1.2E-01
Lead	5.5E+02	3.14	1.3E+03	4.0E+03	1.3E+03
Subsurface Soil (greater than 1 foot)					
Aldrin	6.2E-01	128.69	1.9E+00	2.1E+01	1.9E+00
4,4'-DDD	5.6E+00	46.84	1.3E+01	2.2E+02	1.3E+01
4,4'-DDE	5.7E+00	106.18	1.5E+01	3.0E+01	1.5E+01
2,4'-DDT	7.4E+00	53.67	1.9E+01	5.3E+01	1.9E+01
4,4'-DDT	1.6E+01	41.83	3.6E+01	2.8E+02	3.6E+01
DDT (total)	2.6E+01	36.80	5.7E+01	3.1E+02	5.7E+01
Dieldrin	6.3E+00	278.36	2.3E+01	2.4E+01	2.3E+01
Endrin	4.7E+00	282.40	1.7E+01	6.6E+02	1.7E+01
Lead	2.9E+02	2.98	9.0E+02	2.8E+03	9.0E+02
Soils at All Depths					
Aldrin	4.6E-01	92.57	1.2E+00	2.1E+01	1.2E+00
4,4'-DDD	8.7E+00	47.61	1.8E+01	2.2E+02	1.8E+01
4,4'-DDE	1.2E+01	127.04	2.9E+01	7.8E+01	2.9E+01
2,4'-DDT	1.5E+01	72.20	3.7E+01	1.2E+02	3.7E+01
4,4'-DDT	4.7E+01	69.45	1.0E+02	7.0E+02	1.0E+02
DDT (total)	6.4E+01	52.91	1.3E+02	7.4E+02	1.3E+02
Dieldrin	5.7E+00	236.55	1.9E+01	2.4E+01	1.9E+01
Endrin	3.1E+00	208.73	1.0E+01	6.6E+02	1.0E+01
Lead	4.4E+02	3.14	8.2E+02	4.0E+03	8.2E+02

[1] The values presented in this table include the changes to the database necessitated by the new data reported in Levine-Fricke (1993) and Weston (1993). Units are in mg/kg (ppm) unless otherwise stated.

[2] This is a maximum likelihood estimate of the arithmetic mean of the data assuming the data are lognormally distributed. This is assumed to be the best estimate available for the value of the concentration. Even these values, however, are expected to be somewhat conservative.

[3] The 95% UCL is based on Land (1975) as discussed in Gilbert (1987).

[4] RME exposure point concentration determination is the lesser of the maximum detected value and the 95% UCL. This is expected to represent the *reasonable maximum estimate of soil concentrations.*

[5] The representative concentration for total DDT were derived by summing 4,4'-DDD, 4,4'-DDE and 4,4'-DDT measured in each individual sample and then deriving separate summary statistics for this parameter. Therefore, the sum of the summary statistics representing 4,4'-DDD, 4,4'-DDE and 4,4'-DDT do not strictly add to the summary statistic presented for total DDT.

TABLE 3–3
ESTIMATED EMISSION RATES AND AIRBORNE EXPOSURE POINT CONCENTRATIONS
(ASSUMING VARIOUS EMISSION MECHANISMS)

COCs	CS RME Exposure Point Concentration in Soil[1] (mg/kg)	Q_{10} Estimated Chemical–specific PM_{10} Emission Rates			CA_{10} Estimated RME Exposure Point Concentration in Air[2]		
		Wind Erosion (mg/sec)	Vehicular Traffic (mg/sec)	Excavation and Dumping (mg/sec)	Wind Erosion (mg/m^3)	Vehicular Traffic (mg/m^3)	Excavation and Dumping (mg/m^3)
Surface Soil (≤ 1 foot)							
Aldrin	6.6E–01	2.1E–08	1.5E–04	7.5E–05	3.8E–12	2.7E–08	1.4E–08
4,4'–DDD	3.5E+01	1.1E–06	8.1E–03	4.0E–03	2.1E–10	1.5E–06	7.3E–07
4,4'–DDE	5.6E+01	1.8E–06	1.3E–02	6.4E–03	3.3E–10	2.3E–06	1.2E–06
2,4'–DDT[3]	1.2E+02	3.8E–06	2.7E–02	1.4E–02	6.9E–10	4.9E–06	2.4E–06
4,4'–DDT	7.0E+02	2.3E–05	1.6E–01	8.0E–02	4.1E–09	2.9E–05	1.4E–05
DDT (total)[3,4,5]	7.4E+02	2.4E–05	1.7E–01	8.4E–02	4.3E–09	3.1E–05	1.5E–05
Dieldrin	1.7E+01	5.3E–07	3.8E–03	1.9E–03	9.6E–11	6.8E–07	3.4E–07
Endrin	1.2E–01	3.9E–09	2.7E–05	1.4E–05	7.0E–13	5.0E–09	2.5E–09
Lead	1.3E+03	4.2E–05	3.0E–01	1.5E–01	7.6E–09	5.4E–05	2.7E–05
Subsurface Soil (>1 foot)							
Aldrin	1.9E+00	6.1E–08	4.3E–04	2.2E–04	1.1E–11	7.9E–08	3.9E–08
4,4'–DDD	1.3E+01	4.1E–07	2.9E–03	1.4E–03	7.4E–11	5.3E–07	2.6E–07
4,4'–DDE	1.5E+01	4.9E–07	3.5E–03	1.7E–03	8.9E–11	6.3E–07	3.1E–07
2,4'–DDT[3]	1.9E+01	6.2E–07	4.4E–03	2.2E–03	1.1E–10	7.9E–07	3.9E–07
4,4'–DDT	3.6E+01	1.2E–06	8.2E–03	4.1E–03	2.1E–10	1.5E–06	7.4E–07
DDT (total)[3,4,5]	5.7E+01	1.9E–06	1.3E–02	6.5E–03	3.4E–10	2.4E–06	1.2E–06
Dieldrin	2.3E+01	7.5E–07	5.4E–03	2.7E–03	1.4E–10	9.7E–07	4.8E–07
Endrin	1.7E+01	5.6E–07	4.0E–03	2.0E–03	1.0E–10	7.1E–07	3.6E–07
Lead	9.0E+02	2.9E–05	2.1E–01	1.0E–01	5.3E–09	3.7E–05	1.9E–05
Soil at All Depths							
Aldrin	1.2E+00	3.8E–08	2.7E–04	1.4E–04	7.0E–12	4.9E–08	2.5E–08
4,4'–DDD	1.8E+01	5.7E–07	4.1E–03	2.0E–03	1.0E–10	7.4E–07	3.7E–07
4,4'–DDE	2.9E+01	9.5E–07	6.7E–03	3.3E–03	1.7E–10	1.2E–06	6.0E–07
2,4'–DDT[3]	3.7E+01	1.2E–06	8.5E–03	4.2E–03	2.2E–10	1.5E–06	7.7E–07
4,4'–DDT	1.0E+02	3.4E–06	2.4E–02	1.2E–02	6.1E–10	4.3E–06	2.1E–06
DDT (total)[3,4,5]	1.3E+02	4.3E–06	3.1E–02	1.5E–02	7.8E–10	5.5E–06	2.7E–06
Dieldrin	1.9E+01	6.0E–07	4.3E–03	2.1E–03	1.1E–10	7.8E–07	3.9E–07
Endrin	1.0E+01	3.2E–07	2.3E–03	1.1E–03	5.8E–11	4.1E–07	2.1E–07
Lead	8.2E+02	2.7E–05	1.9E–01	9.3E–02	4.8E–09	3.4E–05	1.7E–05

Methodology for estimating exposure point concentration in air is presented in Appendix C.

[1] RME Exposure Point Concentration determination: the lesser of the 95% UCL and the Maximum Detected Value. See Table 3–2.

[2] Exposure Point Concentration in Air (mg/m^3) = Chemical–specific PM_{10} Emission (mg/sec) x 1/HxWxU (sec/m^3)

[3] 2,4'–DDT was analyzed for in 85% of the samples so that sufficient data is available to include this isomer in our risk analysis. However, because approximately 15% of the samples analyzed for 4,4–'DDT were not also analyzed for the 2,4'–DDT isomer, the 2,4'–DDT isomer could not be properly incorporated into the parameter representing total DDT. Thus, 2,4'–DDT is carried through the risk assessment as a separate analyte. In any case, as demonstrated on these tables, the error contributed to risk if the 2,4'–DDT isomer is ignored is less than 30%, which is small compared to other sources of error in risk assessment.

[4] The representative concentrations for total DDT were derived by summing 4,4'–DDD, 4,4'–DDE and 4,4'–DDT measured in each individual sample and then deriving separate summary statistics for this parameter. Therefore, the sum of the summary statistics representing 4,4'–DDD, 4,4'–DDE and 4,4'–DDT (presented in this table) do not strictly add to the summary statistic presented for total DDT.

[5] 2,4'–DDD and 2,4'–DDE were not included in this analysis because fewer than 30% of the samples were analyzed for these isomers. It is expected, however, that the error to risk estimates contributed by these omissions are small. See footnote 3.

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